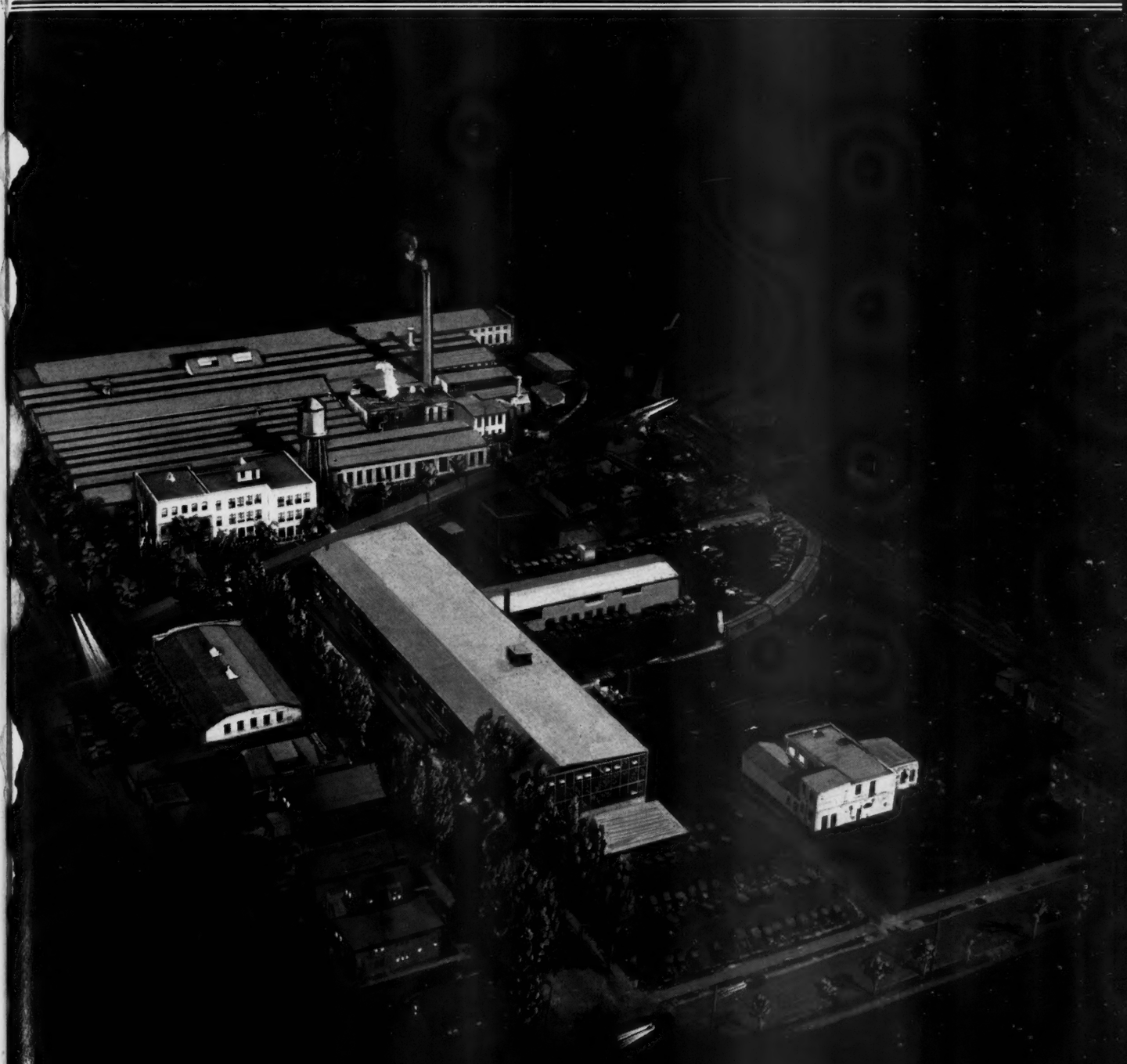
MAY 7 1931

MAINTENANCE ENGINEERING

IN PLANTS, MILLS, AND FACTORIES

FORMERLY "INDUSTRIAL ENGINEERING"



A McGraw-Hill Publication
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MAY - 1931

For cover story
see page 238

FAIRCHILD AERIAL SURVEYS, INC.

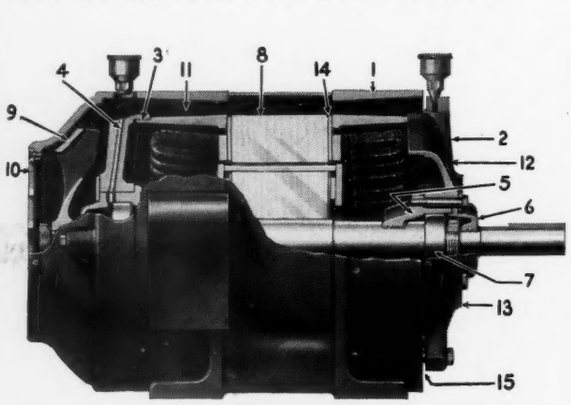
Safeguarded—

against dust, dirt, acid fumes, or moisture

—those factors that tend to shorten the life of windings — the Allis-Chalmers, totally enclosed, fan-cooled motor is ideally suited for operation in chemical plants, foundries, cement plants, crushing plants, mining and coal preparation. Being weather-proof, it is suitable for outdoor service.

Important Features

1—Cast steel end frames in combination with solid bearing housings (No. 2) provide complete enclosure without the use of sheet metal or other auxiliary parts.
2—Cast iron bearing housing serves also as end closure fitted to end frames with long rabbet fit (No. 3). Removable without exposing the bearings.
3—Rabbet fit forms a tight joint between end closure and stator frame.
4—Compression cup and grease duct, an integral part of housing assembly.
5—Bearing cartridge remains on shaft when motor is dismantled.
6—Cap secured to cartridge by screws prevents exposure of bearing and lubricant when rotor is removed.
7—Bearings of standard metric dimensions of medium series, secured by lock nut.
8—Stator and rotor laminations of silicon steel assure minimum core loss.
9—Cast aluminum fan, balanced, keyed and locked on shaft, designed for strength and efficient windage.
10—Fan housing with its grid cover completely isolates fan for safety.
11—Unobstructed air passage made shallow to increase air velocity over cooling surfaces.
12—Flush type pipe plugs for inspection of air gap.
13—Clamping ring.
14—Stator teeth supported by punchings of heavy plate steel.
15—Space for inserting a pinch bar to pry loose the bearing housings.



Sectional View Illustrating the Compact Design, Sturdy Mechanical Construction, and Accessibility.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee

MAINTENANCE ENGINEERING

A McGraw-Hill Publication, founded 1882

MAY, 1931

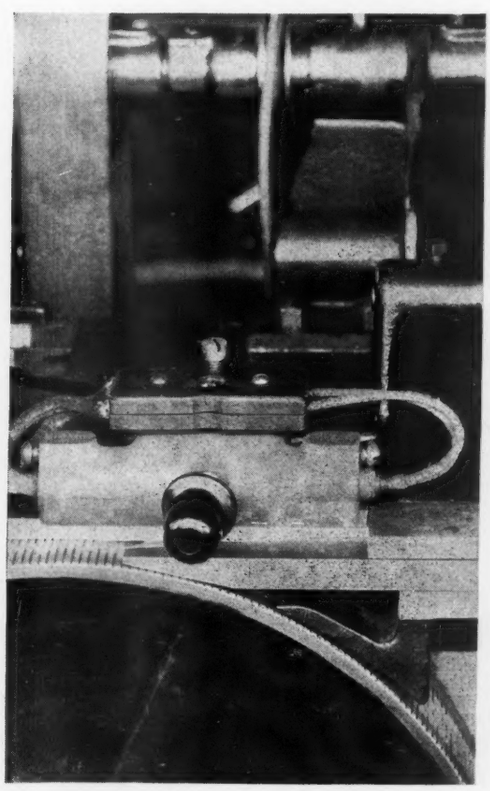
Electric Heating Units for Process Machines

F. E. FINLAYSON
General Electric Company
Pittsfield, Mass.

HEAT for various purposes is required in a great many different kinds of machines. In some the heat is required in large amounts and performs one of the prime functions of the machine. On the other hand, the heating unit may be a small and seemingly insignificant part of a complicated and expensive machine, as in the case of a cigarette machine that requires a small amount of heat to warm glue for sticking the paper.

The modern source of heat for machinery—the electric heating unit—has few of the disadvantages of steam or fuel and is rapidly taking the place of other methods.

Generally speaking, the cost of a heating unit is a comparatively small part of the total cost of the machine; therefore, the temptation may be to consider it an unimportant item. As a matter of fact, failure of the heating unit is usually as serious as the failure of any major part of the machine. For this reason too much care cannot be taken in selecting a unit which will best fill the requirements of heat intensity and distribution and "stand up" under the service. The application of heating units to machinery is one of the most severe tests that can be given them, because of the abuse to which they are frequently subjected and the rigid performance requirements.



Electrically heated sealer in contact with cigarette rod on automatic cigarette machine. Two cartridge-type heating units are employed in the sealer.

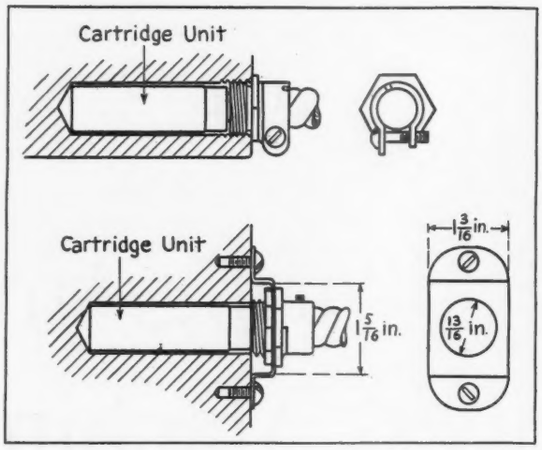
Obviously, a unit that is to meet the peculiar demands of hundreds of unrelated types of machines must be adaptable. Design and construction must be such that the unit can be made to fit into the machine, and the rating in watts and volts must always meet the conditions. Insulation between the live parts of the unit and the machine must be thorough and permanent.

From the standpoint of service, the most important requirements of the heat unit are conservative design and permanently strong construction. If design is not conservative the unit may run too hot and burn out in a short time. Construction of the unit must be such that it will withstand severe vibration, great pressure, oil fumes, dampness, and so on.

Heating units that are incased

in metal are usually best adapted for machinery applications. The metal-incased units are made up in various ways and are known to the trade by such names as sheath wire, cartridge units, or strip heaters.

The sheath-wire type of heating unit resembles a metallic rod having a terminal on each end for electric connections. Such units can be bent and formed in much the same manner as an annealed rod of the same dimensions. One type of sheath wire unit is made by forming a nickel-chromium resistance wire of the proper size into a coil or helix of small diameter. Heavy nickel-alloy wire terminals are attached to both ends of the coil and the resistor with its terminal is assembled centrally in a metal tube.



Method of making flexible conduit connection to a cartridge-type heating unit.

The tube is then loaded with magnesium oxide powder and reduced in diameter by swaging until the magnesium oxide is compressed to a dense mass. The resulting unit is adaptable to formation into practically any shape and is unaffected by vibration. The magnesium oxide which surrounds and supports the resistor is not only a highly refractory material, but in this highly compressed form is a conductor of heat and an insulator for electricity.

The cartridge type of unit is generally similar in construction to the sheath-wire type except that the resistor coil is not self-supporting and both terminals come out of the same end. The resistor coil in the cartridge unit is wound on a supporting core and the space between the core and the casing is filled either with compressed magnesium oxide, or with some other form of heat-resisting insulation, such as mica.

The so-called "strip" type of heating unit, as the name implies, is a metal-incased heater resembling a piece of flat strap iron, generally about 1½ in. wide and of suitable length. Terminal connections are usually on the top side at either one or both ends. This type of heater may also consist of a formed resistor inclosed within a metal case and separated from it by a suitable insulating material. The cast-in unit is made by forming a piece of sheath wire into the shape required, placing it in a mold and pouring molten metal, usually cast iron, around it. This type of construction has the advantage of readily providing a large area for the dissipation of heat. It also protects the sheath wire from mechanical injury and oxidation.

Calculating Power Requirements

The amount of heat required to maintain the proper temperature in a given part or machine is often dependent upon so many varied conditions that it is practically impossible to calculate the power requirements. In such cases it is best to experiment with units of various ratings until the proper size is determined by trial and error. Where this is not practicable, calculations should be made to determine the rating as closely as possible, and the unit employed should be of ample capacity, as it is easier and safer to reduce the rating than to increase it.

Calculations of heat requirements must generally take into consideration the following:

1. The thermal capacity of the entire mass of material being heated. This is particularly important in determining initial heating-up time.

2. Heat taken away by the work passing through the machine.

3. Heat losses due to conduction, radiation, and air convection.

The coefficient of thermal capacity of a substance is referred to as its specific heat. It is expressed as the ratio of the number of heat units which a unit weight of the substance will absorb per degree temperature rise, to the number of heat units an equal weight of water will absorb with the same temperature rise. The table gives the specific heat of a number of common substances. When making calculations it is customary to consider the specific heat as the B.t.u. required to raise 1 lb. of the substance 1 deg. F. Therefore, the formula for determining the heat required to raise the temperature of a substance through a certain number of degree is:

B.t.u. = *Specific Heat* × *Weight in Lb.* × *Temp. Change in Deg. F.*

SPECIFIC HEATS OF SOME COMMON MATERIALS

Metals		Solids	
Aluminum	.22	Alumina	.197
Antimony	.0508	Charcoal	.241
Copper	.0951	Brickwork	.20
Brass (red)	.091	Coal	.20 to .24
Brass (yellow)	.088	Glass	.1937
Gold	.0325	Graphite	.202
Wrought Iron	.1138	Marble	.21
Cast Iron	.130	Stones, Generally	.20 to .22
Lead	.0314	Sand	.20
Nickel	.109	India Rubber	.48
Platinum	.0324	Wood—dry	.33
Silver	.057	Paraffin	.40 (approx.)
Tin	.056	Asphalt	.40 (approx.)
Zinc	.095	Sulphur	.205
Type Metal	.039	Ice	.50
Mercury	.033		

Liquids			
Water	1.00	Turpentine Density .87	.472
Sulphuric acid Density 1.87	.335	Castor oil	.440
Density 1.30	.660	Petroleum	.510
Hydrochloric acid	.600	Ether	.504
Benzine	.45	Olive Oil	.47

To express the heat requirements in watt-hours instead of B.t.u., it is simply necessary to divide the result obtained above by 3.412. Thus:

Watt-hours=(Specific Heat×Weight in Lb.×Temp. Change in Deg F)÷ 3.412.

Heat losses are difficult to calculate accurately unless the body being heated is more or less isolated and conditions are known and constant.

Heat losses by convection and radiation depend upon the temperature gradient and nature of the surface. The curves on page 224 give the amounts of these losses per square inch of exposed surface under various conditions.

Methods of Application

Machine parts are most frequently heated by direct contact between the part and the heating unit; or, if the machine contains a liquid to be heated, by immersion of the heating unit in the liquid.

Where the heat must be concentrated and the temperature required is relatively low the cartridge-type unit is ideal for the application. However, as most units of this kind use brass as the sheath material, a temperature of 750 deg. F. on the surface of the unit is considered the practical limit. For applications requiring temperatures up to about 1,000 deg. F. cartridge units can be obtained having a special sheath which will stand such temperatures.

The cartridge-type unit is best applied by inserting it in a slightly-oversized hole in the part to be heated. The illustration on page 222 shows a unit installed and method of making flexible conduit connections. Standard units are obtainable in a great variety of sizes and ratings.

In applying the unit it should, as a rule, be placed as close as possible to the point where heat is required, and in proper relation to it. Thus, if water in a container is being heated the unit would naturally be placed under the water, but if a die block is to be warmed the unit should be placed near the required surface, irrespective of position.

Sheath wire can be applied to more types of heating jobs than any other kind of heating unit made. Without change, other than perhaps the use of a different sheath material, sheath wire can be used to heat surfaces by any one or a combination of three general means: (1) By direct contact between the unit and the surface; (2) by conduction of the heat through some medium, such as gas or a liquid; (3) by means of radiant heat from the unit. Sheath wire is, however, rarely primarily used as a radiant heater, because it is necessary to operate it at a temperature which is not generally considered advisable.

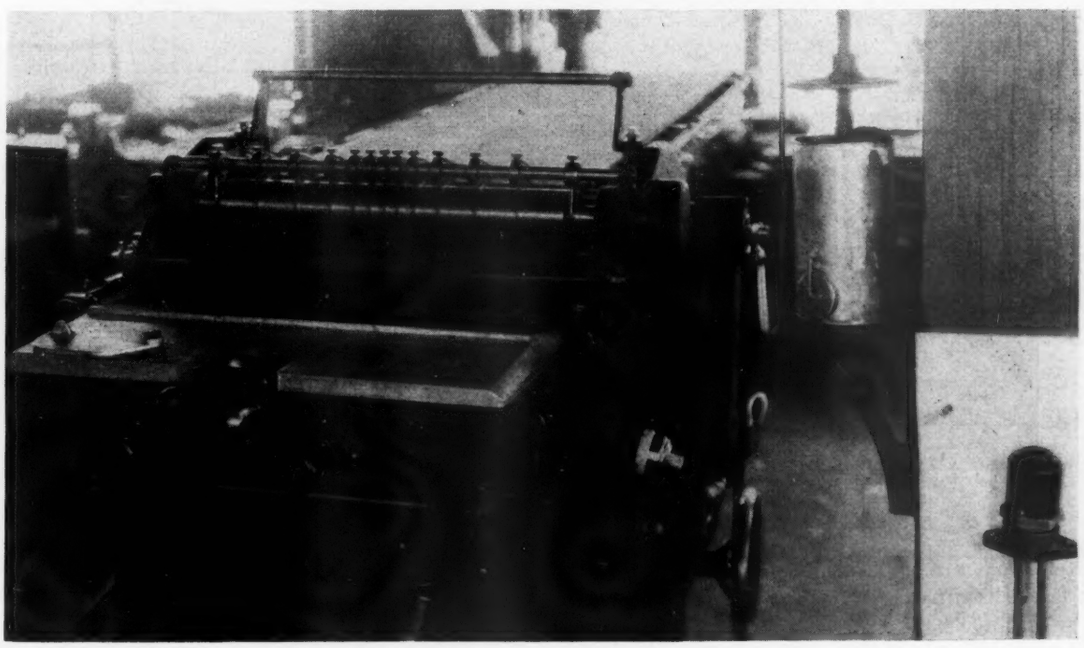
Ordinarily sheath wire for industrial applications is limited to temperatures around 1,000 deg. F. Where it is found economical to go to higher temperatures, even at the cost of relatively short life, it is necessary to use a sheath of some heat-resisting metal not subject to serious oxidation.

When sheath wire is used to heat a surface by direct contact it is first formed into the most effective shape and is then applied either directly on the flat surface or in grooves shaped to increase the area of contact with the unit. In either case it is always well to make certain that the unit is tight against the surface at every point.

Where very uniform heat is required on a part or device indirect heating may be resorted to. The mediums most used for indirect heating are air, steam, water, and oil. Indirect heating by air can be accomplished by simply fashioning a kind of oven around the part to be heated which will inclose the heating units. When using this method the temperature gradient between the units and the part will be much greater than in the case of contact heating and the units must be rated accordingly.

Steam generated electrically is becoming widely used as a source of heat in process machines. The electric steam generator is a highly efficient, economical, and convenient means of supplying steam. Practically all of the smaller-sized electric steam generators are equipped with sheath-wire immersion units.

Indirect heating by means of water or oil has long been used with fuel as well as electricity where temperatures must be uniform and well con-



Automatic glue machine for box-wraps and labels, equipped with two immersion-type electric heating units.

trolled. A common example is the heating of glue. Where water is used with electric heat the part or device to be heated is jacketed for water or immersed directly in the water container. The water is heated by means of immersion heaters, or by applying heat to the container.

Indirect heating by oil can be accomplished in the same manner as with water, and much higher temperatures can be reached. However, oil introduces a fire hazard. Also, as oil will not absorb heat nor circulate as freely as water, the units cannot be rated so high in watts per square inch. Oil has a tendency to carbonize on heating units, causing them to overheat.

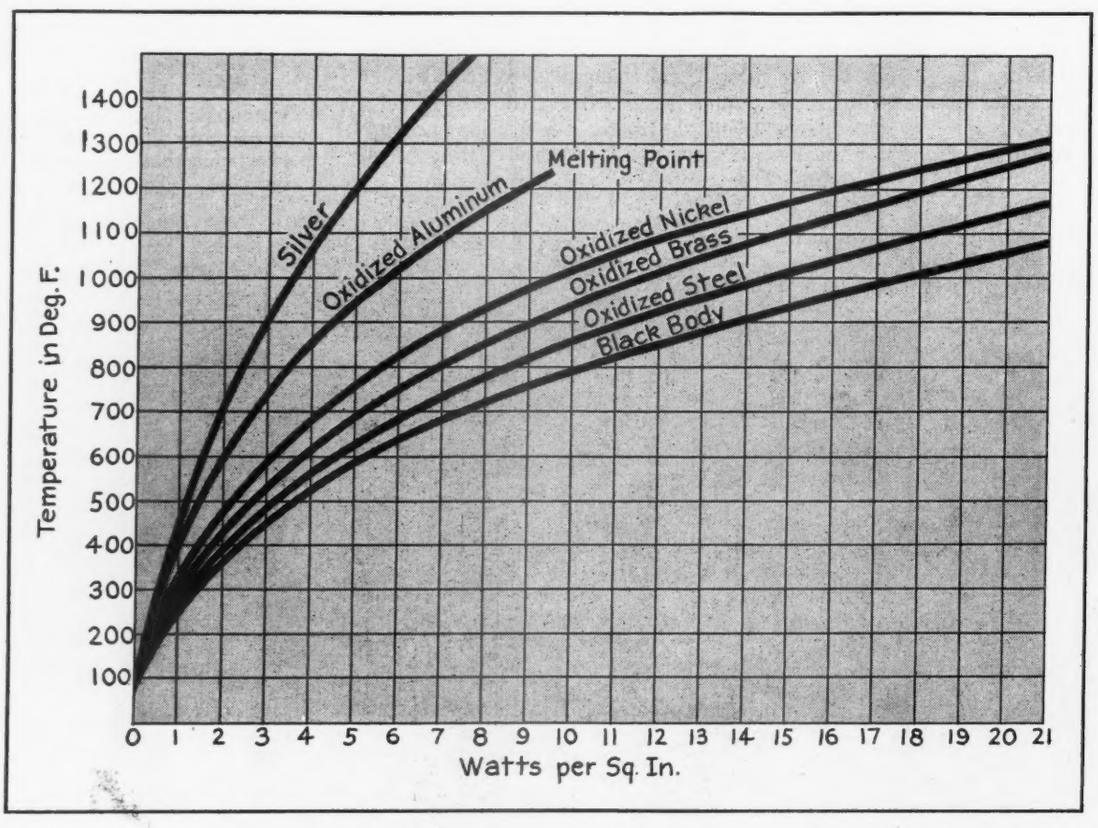
A favorite method of indirect heating with oil employs a separate container for heating the oil and a pump for circulating it to the places where needed. Immersion units for use in oil having forced circulation can be rated higher than for similar conditions in still oil.

The strip type of heating unit is used on many different kinds of heating applications, but is limited by the fact that it can be applied only to relatively flat surfaces, and to the heating of air. Some types can be bent on long radii, but at the risk of buckling the sheath and injuring the unit. In general it is better to consider the sheath-wire type of unit where any formation is considered necessary.

Strip heaters are applied by clamping the flat side firmly against the part to be heated, in the case of contact surface heating. When used for air heating they are simply suspended in the space to be heated, taking care to allow for free circulation of air. The standard strip heaters available on the market at present are, generally speaking, rated conservatively enough so that they can be operated in almost any reasonable way without danger of overheating.

For most of the industrial applications of electric heating, heat lost into the atmosphere without having performed its function is money wasted. Therefore, when installing electric heat it is always well to give careful consideration to insulation. The function of insulation is to retard the flow of heat and it should, therefore, be applied to, and only to, the surfaces where heat is not required or where losses will occur. Insulation carelessly applied can also retard the flow of heat in the direction of the work, thereby causing the heated part to run needlessly cool and the unit to overheat.

When sheath wire or strip heaters have been applied to a surface, insulation should not be packed closely around the backs of the units, for it is sure to sift around between the unit and the surface to be heated. Rather, a sheet of metal should first be applied to cover the units and the insulation put on the outside. This gives, in effect, a narrow oven which helps to dissipate the heat of the unit by radiation and air convection, as well as by contact between one side of the unit and the surface. The type of insulation to be used will depend partially upon the temperatures involved. For low temperatures, such as are encountered in water heating, a thick blanket of felt or similar material is satisfactory. For higher temperatures mineral wool, asbestos, 85 per cent magnesia, or diatomaceous earth are recommended. The latter two are used to the exclusion of practically all others in the high-temperature applications such as electric heat-treating furnaces.



Heat losses from plane vertical surfaces of different materials, at a room temperature of 68 deg.

Mechanical Lifting Methods Increase Net Profits

L. B. MURDOCK

ONE of the advantages of a period of quiet business is the opportunity it provides for plants to study their handling methods. Operations which obviously cost more than they should are often overlooked during peak periods for lack of time to work out a better way. When production drops off, the antiquated ways of doing certain jobs are more apparent than ever and, during such a time, can be analyzed properly and corrected with little or no interruption to production.

The primary purpose of developing proper handling methods is reduction in operating cost, but any number of more or less indirect benefits invariably accompany such improvements. Fewer accidents and injuries to workmen, less product spoilage, and reduction in maintenance costs are just a few of the intangible benefits that follow such a move.

Methods of operating, whether good or bad, have their effect upon the ultimate selling price of the article manufactured, whether it be a luxury or one of life's essentials. Perhaps the most outstanding example of what proper handling methods will do for the manufacturer is the present-day automobile, generally accepted as the "biggest dollar's worth" obtainable. Cars which only a few years ago sold for what seemed to be reasonable prices are now available for approximately one-half or less, and in improved designs. The underlying reason for this lies mainly in improved machinery and complete coordination in handling parts between the various processes of manufacture. Efficient equipment and the resulting elimination of waste motion are fully appreciated by this industry. The results obtained have been reflected in consistently lowering selling prices.

The automotive field is a good standard of comparison as everyone is more or less familiar with it. But what has occurred there is also happening, to a proportionate extent, in other industries as well. Even plants of modest size realize the very definite relationship between proper handling equipment and net profit, and its influence on the final selling price.

A recent survey taken in a Chicago plant illustrates this point clearly. This firm, whose business involves the handling of quantities of case and skid goods, has installed electric stacking equipment with marked success. Their case stacker is of 750-lb. capacity and operates from a lamp socket. A ½-hp. motor controls the load in both the "up" and "down" directions at a speed of 20 f.p.m. Prior to the installation of this machine, the cases were piled with the aid of a hand-operated lift which, although better than doing the job entirely by hand, required two men to operate it and one for trucking the cases to the lift. With this arrangement it cost 12 cents to handle each case. The operation entailed considerable physical effort and exhaustion. The speed was slow at best with a decided decrease toward the end of the day as the men grew tired. Seldom were more than 100 cases raised and put in place in a nine-hour day.

With the electric piler, the same crew of three men now pile from 250 to 275 cases per day and are less tired when the end of the day comes. The increased speed has reduced the cost of handling to 5 cents per case or a saving of 7 cents per case handled. Based on an average of 700 cases handled weekly, the saving amounts to $49 per week or $2,548 annually. This saving is sufficient to return the first cost of the electric piler at the rate of 386 per cent per year or almost four times a year. This is the estimated net saving which was ar-

Electric stacking equipment meant a 50 per cent increase in storage space and an increase of approximately 150 per cent in the number of units handled.

rived at by tabulating the depreciation, interest on investment, maintenance, operating expenses, labor, and other incidental expenses necessary to do the work with the electric machine as against the hand-operated unit.

The power consumption is low, the current cost for a full day being approximately three cents. This is accounted for by the fact that the elevating platform travels to the top of the lift in less than 30 sec. and the full trip is made only about 25 per cent of the time. The motor operates only when the platform is in motion. And the platform is in actual motion only about four hours out of every nine which constitute a full working day.

Putting operating costs on the most economical level possible necessitates that every bit of storage space be utilized to best advantage. Not only the floor space, but the overhead area as well, must be used and in the cheapest way possible. This is fairly simple in instances such as the one described where the item involved is of moderate size and weight. Where the article totals, say, 2,000 lb. or more, and varies in size, the handling becomes more difficult and, unless proper means are employed, quite dangerous.

Material on skids presents just such a problem. The average skid of paper stock ranges between 4 and 5 ft. in height and is about 3½ ft. wide by 5 ft. long. Such a load weighs between 3,000 and 5,000 lb., depending upon the grade of stock. The weight and awkwardness of the pile make it highly impracticable to attempt to put one upon the other by hand. So, unless mechanical assistance is installed, only one-half or one-third the possible storage capacity can be obtained from a given area. In some instances, contemplated new buildings, considered necessary to obtain additional floor space, have been found unnecessary after an electric lift truck or stacker was put to work.

Before electrically operated equipment was installed, the handling cost of each case was 12 cents. Now it is 5 cents.

With the average machine equipped with a 3- or 5-hp. motor, it is possible to double-deck from 40 to 50 skids an hour. One worker can manipulate the machine with the load on it while another brings the skids to the proper point. When necessary, the entire job can be done by one man, as no manual lifting is involved—just a combination of trucking operations.

The principal saving of such a lifter lies in its ability to stack skids but, figuring each skid piled provides approximately 17 sq. ft. of additional space not otherwise available, a $1,500 investment in machinery is soon returned. Floor space varies in value from 35 to 50 cents per sq. ft. per year, according to the locality. Estimated depreciation, interest on investment, repairs, power, and labor necessary to operate such a hoist amount to approximately $300 per year. This information, of more or less general character, can be used to determine the savings possible in any plant where skid goods are carried in stock. A 10-ft. ceiling permits skids of average size to be double-decked and storage space practically doubled while a 15- or 16-ft. overhead clearance will accommodate three tiers. The latter, while not as common as the double stack, is practicable and advisable from the space-saving standpoint, giving 50 per cent more storage than skids piled two high. The cost of the taller hoist, necessary to stack three high, is just a few dollars more and is purchased, in some cases, in anticipation of future needs.

Possibility of damage to the lower skids is prevented by placing boards beneath the legs of the upper skids. This distributes the load over a sufficient area and avoids spoiling any of the material below.

With the ever-increasing tendency toward the skid method of shipping and handling, too much attention cannot be given to safe and efficient means of storage and transportation.

PLANT ENGINEERS' FORUM

Here is the twentieth of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to previous questions also will be published. Write down your opinions and send them to the editor. Answers published will be paid for at an attractive rate.

Who Orders Repair Shutdowns?

This month, as the drop rises, we see George Shipman and Frank Fulleger in a downtown restaurant. These two men are, as you know, a works manager and a plant engineer of different plants. Shipman, who many times has given Fulleger good advice on plant problems, begins the conversation.

* * *

"I know what brings you downtown this noon, Frank, because I'm here for the same reason. It's the last day to pay the little tax bills our city fathers blessed us with."

"You're right, George, and now that I'm here I've a good mind to knock off for the afternoon—don't seem to amount to much at the plant, anyway."

"Why so grouchy? You talk as though teacher had just spanked you."

"No, he hasn't, but maybe he will, because I'm likely to tell teacher a few things."

"Out with the story, Frank. What's the trouble?"

"Just this: Right now we have a six-day repair job on our hands, including plenty of overtime. And why? Because teacher wouldn't shut down a wood planer last month for a day's repair."

"Now it's broken down, I suppose."

"Broken down is right, George. It's thoroughly out of commission—and a week's shipments will be held up because we can't supply packing cases. After that, overtime until we catch up. What's the use of maintenance inspection systems, anyway, if the superintendent can break them up to suit himself?"

"Let me get this straight, Frank. Your men reported the necessity for the repair. What did you do?"

"I listed the job along with the others on my report to the superintendent. Pointed out that it was advisable to do the job the next day. When the list came back he had made notation that the repair would have to be postponed for three weeks, anyway."

"So you were deadlocked, eh, Frank? And no referee?"

"That's the situation, and my department will hold the bag. How am I going to carry on the right kind of preventive maintenance when I can't order machines shut down?"

* * *

The curtain drops before we have a chance to hear the constructive advice that, undoubtedly, George Shipman handed out. Well, so much the better—let's work it out for ourselves.

Who shall say when equipment is to be shut down for repair?

At least three solutions to this problem appear obvious, but second thought shows that each has a flaw. It is a real problem—let's have a real answer.

(Answers to previous questions start on the following page)

READERS' ANSWERS

to previous questions

Should Maintenance Engineers Attend Conventions?

(Question presented in the April issue)

BY all means send the maintenance engineer to conventions that deal directly with his field. He is certain to come back with at least one idea that will more than repay his expenses. Aside from the technical sessions and discussions, the contacts which one makes with other key men in the industry and the accompanying interchange of ideas are invaluable to both management and the engineer.

H. S. DEELEY, *Planning Engineer*
Canadian Johns Manville Company
Asbestos, Quebec

I BELIEVE that if a maintenance engineer goes to a convention, attends the meetings, and studies the exhibits, it is beneficial to the company he represents.

By attending the meetings and listening to the papers read, the maintenance engineer obtains the other fellow's viewpoint. Then, too, there is always an opportunity given to discuss the papers.

The manufacturers always exhibit the latest devices. By giving these a thorough study the maintenance engineer may be able to recommend some for use in his own plant, thereby saving money for the firm.

I have attended many conventions and always have felt that I received some benefits by attending. Upon my return the superintendent would make some comment, such as "Did you see that new automatic electric arc welder put out by the so-and-so company? What do you think of it? Can we use it in our plant?"

By all means send your maintenance engineers to the convention if you can afford it, but when you have sent them see that your money has been well spent by finding out what they have learned in a written report.

J. WALTER WRIGHT, *Assistant to the President*
Wilmot Fleming Iron & Steel Company
Philadelphia, Pa.

MAINTENANCE engineers of any plant will find it very instructive and beneficial to attend conventions on subjects directly connected with their business. These conventions furnish new ideas and suggestions for carrying out and solving problems in any plant. They also furnish opportunity to visit plants to which it would be impossible to gain admittance as an individual. At some of the conventions displays of industrial equipment are shown and the latest developments in machinery and process work can be examined at first hand.

The field of maintenance engineering covers such a broad subject that it is necessary to attend various types of meetings, dealing with such subjects as safety, power, transmission, building construction, production machinery, electrical displays and industrial engineering.

The last two or three years have brought the subject of maintenance to the interest of management to such an extent that they are demanding the subject be discussed thoroughly. I believe any owner or manager of an organization will do well to allow the maintenance men to attend conventions where ideas can be obtained and applied directly to the operation of their plant.

K. D. HAMILTON, *Mechanical Department*
Geo. E. Keith Company
Campello, Brockton, Mass.

ATTENDANCE at certain conventions certainly should be worth while to any maintenance engineer. The papers read and subjects discussed should supply an abundance of new ideas and the contacts made with other engineers should prove helpful and may lead to co-operation on future problems.

Before attending a convention the engineer should give the advance program careful consideration to determine whether or not the subjects to be treated are of such nature as to be helpful to him. Promiscuous convention attendance is just a waste of time and money and it will usually be found, after considering all of the convention and exposition invitations and notices received, that possibly only one or two of them each year will actually pay dividends in the form of information received.

C. W. SCHWABE, *Superintendent*
Mechanical Department, Mallinckrodt Chemical Works
St. Louis, Mo.

To Whom Should the Maintenance Department Report?

(Question presented in the March issue)

IF the plant has a mechanical engineering department, the reporting should be done to the chief of this department; otherwise, it should be direct to the management. The maintenance department should never report to the production department for, although their interests are to a large extent mutual, they also are largely diverse.

I base my conclusions on experience under both conditions. The head of the production department is primarily interested in keeping the machines in good order to keep production flowing smoothly. Will he be big enough, when he has a rush order, to see the maintenance view of the question? It has been my experience that usually he will prefer to take a chance that everything will go right until the order is completed. If it does not go right, the company is likely to be out a good

many dollars more than they would have lost had the production on the machine been suspended temporarily. It is much better to have questions of this sort settled by the management, the men who hold the company's pocket book and know just what they can and cannot afford.

I have never seen anything but dissension come from placing maintenance under production supervision. On the other hand, where maintenance was controlled by the mechanical head or the management direct, there has always been the utmost efficiency. The head of any smoothly working production department has enough on his hands without carrying an additional load with which, nine out of ten times, he is only vaguely familiar.

CHAS. R. WHITEHOUSE, *Standards Engineer*
The Holtzer-Cabot Electric Company
Boston, Mass.

THE maintenance department should report to the management. Equipment is so important in modern industrial plants that the maintenance man is entitled to equality with the production man. Surely he should not be placed in the position of the "handy man" in the smaller plants of a few decades ago.

The production department is expected to obtain the largest possible production at the smallest possible cost. The production man considers equipment and maintenance—but only in the light of his own position—as cost factors, not as problems in themselves. He is not fitted, either by training or by incentive, to consider them as more than secondary problems.

On the contrary, equipment and its maintenance are matters of primary importance to the success of the entire business. Modern production methods are based mostly on equipment adequately maintained. Lacking this equipment production becomes economically impossible. Is not the department responsible for it sufficiently important to report directly to the management? Why hire competent maintenance men and then reduce their value by having them report to superiors who know less about maintenance than they and whose main interest is elsewhere? This policy defeats the first principles of preventive and constructive maintenance.

HOWARD W. HARPER, *Assistant Chief Electrician*
The American Tube & Stamping Plants
The Stanley Works, Bridgeport, Conn.

THE maintenance department should report directly to the management, represented by the general superintendent.

The scope of maintenance is very broad, reaching all the divisions of the plant organization with its many services, which include: power generation, distribution, and equipment; structures and buildings; upkeep of mchanical and electrical equipment; and new construction and installation. To operate efficiently in manufacturing, a plant is enhanced to a marked degree by a modern, up-to-the-minute, live-wire maintenance division. There is not likely to be a successfully operated production division if it is serviced by antiquated maintenance methods, such as are usually found where the maintenance program is carried out under the supervision of the production division.

Usually, the production man looks upon maintenance as a necessary evil to be rushed through whenever an emergency breakdown occurs. This, in itself, is the one aspect which the live-wire maintenance men seeks to avoid by careful planning, and by carrying out a regular routine of inspections and minor repairs, which tend to offset or minimize the occurrence of major breakdowns of production machinery with their ever present loss of time and money. Production departments are always busy endeavoring to keep up schedules and, with a hundred and one other problems along the line of manufacture, they are crowded to such an extent that they have not sufficient time to devote to the effective direction or the careful planning of a modern maintenance program. There can be but one result with such an organization operating: Maintenance and upkeep of equipment and buildings will fall off to the point at which major repairs occur so frequently that the program shows itself to be economically unsound.

To operate most effectively and efficiently, a maintenance department should be organized as a separate division of the whole works organization, and the head of the department should rank with the chiefs of the other departments and be directly responsible to the management, in the person of the general superintendent.

E. M. DETWILER, *Plant Engineer*
Worthington Pump & Machinery Corporation
Buffalo Works, Buffalo, N. Y.

How Valuable Are Plant Visits?

(Question presented in the February issue)

IN my estimation visiting plants is of untold value to any man connected with plant operation, and of special value to his firm if the visits are to plants similar to his own. His firm is more than justified and is repaid many times over the cost of such visits. I have visited many plants and have learned much valuable information both for myself and firm.

On one trip worth mentioning, which lasted only two days, I saw a slightly different design in a machine common to all plants of our kind. After changing the design of our own equipment accordingly, we found that it increased production to such an extent that it would have cost $20,000 for additional equipment to do the same work. The change in design was made in one week by the plant maintenance crew. I have shown this improvement to several plant engineers who have visited our plant. They recognized at once the benefit of this change and have done likewise, obtaining similar results.

Very often objections are made to the visits of engineers from other plants, in some cases rightly; but, when visits are reciprocated, one seldom gives any more than one receives, because there is always something different to be seen, or some way of doing certain work differently in every plant, irrespective of size.

I had a plant engineer, from a plant as big again as ours, visit me. I asked him what production he was getting on a certain machine. He replied, "I guess a little better than the average." I knew of three plants that were doing better than he was, and still were not satisfied. When told of these cases and shown our rec-

ords, he was surprised and said, "I shall have to wake up."

I believe that when Frank starts his visits he will find that he hasn't as many cards and spades as he thought he had. In visiting plants one becomes broader-minded, loses any conceit he might have, and carries out his work with a great deal more confidence than before, knowing that he is up to the times and not in a rut.

E. M. CORNELL
Assistant Superintendent and Chief Engineer
Black River Power Company, Limited
Montreal, Canada.

I believe that plant visits are of vital importance to all corporations operating more than one plant. The value received from plant visits rests entirely upon the type of man you have for a maintenance engineer. He must be able to determine quickly whether or not he will be able to use in his own factory the method used by some other plant, or whether a method used in his plant would be adaptable in another, not forgetting that different conditions exist.

In visiting plants of our company I always select the most efficient and most easily adopted plan for our plant. Then I call in the engineer at the plant I am visiting and have him inform me of every detail, after which, if I consider it worthwhile, I try to adopt it in our plant. I tell the general manager from whose plant I obtained it, and ask him to compliment the engineer from whom it was obtained by letter, and send copies to all our plant engineers. These letters show that the engineer from whom it was obtained is getting due credit.

If I think our plant has the best methods I discuss them with the engineers of the other plants and try to get them adopted. I ask them to let me know later whether or not they are a success. At various times I call in the engineer of the next plant to improve my methods. The result is that every engineer is constantly on the alert for something better, something to cut the cost of production and to let the company for which he works know that he is putting forth his best efforts to make himself a better engineer, and them a bigger corporation.

Frank should try to have his force so organized that he can leave and they will continue to operate. Organization is worth more to the company than all any one man can do by himself.

Also, Frank should remember that when any engineer or business man is satisfied with his knowledge and business, it will not be long until he is a past issue.

WM. LEE LANGLEY, *Superintendent*
Lipscomb Grain & Seed Company, Inc.
Springfield, Mo.

Bonus for Maintenance?

(Question presented in the January issue)

PAYING a bonus for maintenance work is as feasible as paying a bonus for extra production. When the maintenance crew is up to its neck in work it is quite reasonable to expect that some part of the production department is tied up. Also, repairs usually mean a steady drain on stores.

As I see it, the point of highest efficiency is when the maintenance crew is inspecting equipment that is running full time and overhauling equipment that is idle. No industrial plant can get along without a maintenance crew, but if the hardest job the maintenance crew had to do was to draw pay checks the plant would be farthest ahead. When the maintenance crew is comparatively idle the production crew is working at highest efficiency, production is of a better quality and commands a higher market price, maintenance material is resting quietly on the store room shelves, and the company is not only making more money, but saving more.

Why not bonus the maintenance department on a basis of "the smaller the repair bills and the greater the idle time, the higher the efficiency and the larger the bonus"?

If the production crew receives a bonus it is due to the fact that the equipment is kept in perfect running order by the maintenance crew, so why discriminate?

H. E. STAFFORD, *Electric Engineer*
Port Arthur, Ont., Canada

Who Shall Specify Equipment?

(Question presented in the October issue)

THIS question of relationship between the maintenance (or plant engineering) department and the purchasing department in regard to specifications for plant equipment has always been a vexing one. It is one which cannot be settled by any general delegation of responsibility, but which depends in great measure on individual circumstances in specific cases. However, some general precepts, depending more on common sense than the exact rules by which they may be expressed, can be laid down for the mutual good of the organization. The first and foremost is that the solution should be developed as far as possible from the controversial background of personal authority. A spirit of co-operation should be fostered at all times, and neither the plant engineer, purchasing agent, works manager, etc., should be permitted to reverse another's decision or change a request without at least rerouting the change to its originator.

Oftentimes an individual specification may be written without great effort by avoiding too much detail, dealing primarily with what the desired product or machine is to accomplish, and stating that alternate bids, with properly defined exceptions, will be considered.

Where bids are invited, and the low bidder fully meets the specified requirements, the award is a mere routine matter for the purchasing agent. If alternate bids are lowest, or if some manufacturer other than the one or ones whose product was specified by name proves to be the low bidder, then the purchasing agent should refer such proposals to the plant engineer for recommendation.

If the plant engineer objects to the low bidder, he may make suitable recommendation as to the bidder whose product he desires, but he should not be permitted to do so by a mere matter-of-fact statement of name. The purchasing agent is entitled to reasons, and real ones (better product is not a good one), as to why the low bidder is not acceptable. Reducing such reasons to paper may seem an irksome task to the plant engi-

neer, and may even appear disrespectful of his technical judgment and authority, but experience has shown that often the most vehement insistance has vanished into thin air when the plant engineer tried to reduce it to logical arguments on paper.

So far, nothing has been said of the works manager's part in these transactions. However, if applied common sense is followed in the spirit rather than the letter of the rules, his will be a very minor role. Most disputes will be settled by mutual agreement between the purchasing agent and the plant engineer. In the few instances where a hopeless deadlock of opinion occurs, it will be the works manager's job to decide—and it will be reasonably certain that neither side to the dispute will appeal for decision unless they can master formidable arguments to back their individual opinions. Even getting ready to make an appeal will often disclose to one or the other that the other fellow is right.

JOHN F. HARDECKER, *Chief Draftsman*
Naval Aircraft Factory
United States Navy Yard
Philadelphia, Pa.

What Maintenance Policy During Depression?

(Question presented in the September Issue)

"KEEP up maintenance at all times." When this is the practice there are a great many plant functions that have to be deferred if the business is pushed for continued operation. Accordingly, very little can be done beyond immediate repairs without resorting to considerable temporary work and tedious Sunday activity.

By taking advantage of restricted production demands, inspection and repair work can be carried out more thoroughly with labor on a straight-time basis. During this period such work that can be done economically should be the first to receive attention.

Difficult building repairs probably come first, owing to the fact that they can be done at less cost and with greater safety than when roof repairs are being conducted over machines in operation.

Repairs to floors when production demands are high tie up all available floor space. Re-routing material is sometimes necessary, which increases the cost. These repairs and other work such as cleaning and overhead painting carried on near a machine in operation very often spoils the product.

Another important function that is put off is the cleaning of the process system. Vats, piping, and containers need a thorough cleaning at frequent intervals.

In a paper mill, when cleaning is deliberately deferred stock pipes, pumps, etc., become fouled with rust, scale, and other foreign material, which break loose at times, contaminating the product to such an extent that it has to be put through the preparation process again. In addition, there are a great number of wooden stock tanks to be cleaned and repaired. Beaters to be cleaned, bed plates chipped and rolls refilled. Jordans to be cleaned and the plug chipped or refilled.

Equipment can often be relocated, with the resultant effect of shortened drives thereby releasing needed floor space or head room. Line shafts checked for alignment; machines and materials-handling equipment rearranged for straight-line production.

In the power plant, boilers, stokers, and furnaces given needed attention; steam leaks stopped; flow meters and other instruments checked and recalibrated. Prime movers overhauled; steam turbine dismantled for inspection and rebladed if needed. Generators and large motors taken apart, cleaned, and painted. Bearings checked; oil leaks stopped, and insulation tests made.

Main-feed oil switches tested; contacts changed, and condition of oil noted. Control wiring inspected. Transformer coils removed from the tanks for inspection; coil ventilating ducts cleaned, inside and out. Disconnecting switches cleaned and the bases painted. Substation steel cleaned and painted.

Switchroom interiors cleaned and painted. Machine lighting checked. Belt drives renewed and so on.

Industry can help itself by putting its buildings and equipment in first-class operating condition during slack periods. By doing so the plant will be in good running order with a minimum of expense during rush production.

MARIN PHILLIPS, *Electrical Superintendent*
International Paper Company
Niagara Falls, N. Y.

DURING this business depression many manufacturing plants in various industries are wisely taking advantage of the opportunities which are now afforded and making additions and improvements to their respective plants. In a current issue of a trade magazine there were notes of an aviation company making additions costing $125,000; an electrical concern building a plant addition at a cost of $50,000; a large steel mill installing a coal-washing plant and other equipment costing $2,000,000; a large copper company remodeling a smelter, spending $2,000,000; and a railroad spending $500,000 on additional equipment.

At present it is imperative to spend money on the needed improvements in buildings and the buying of modern machinery, even if it is necessary to pass a quarterly dividend, because the money now spent in modernizing the plant will help pay increased dividends later when business is back to normal. Also, the plant will be ready to manufacture its product much more economically and make deliveries much more promptly than competitors who have not been foresighted.

In making improvements during this depression the plant engineer has a better pick of the skilled mechanics, and as most plants are working on a curtailed schedule, a greater portion of this work can be done during the regular working hours, and not on an overtime basis, thus cutting the costs. Machinery and building material prices are at low level and deliveries can be made very promptly.

When a plant starts on an expansion and modernization program it is helping to improve the present business depression, as work is given to men in other industries which are manufacturing the material necessary to make these improvements.

W. D. BRISTOW, *Chief Electrician*
Washburn Wire Company
Phillipsdale, R. I.

POWER FACTOR

A down-on-the-ground explanation of what low power factor means, what its effects are, and how it is measured

E. S. LINCOLN
Consulting Engineer
New York, N. Y.

POWER factor is a term hard for the layman to understand, and difficult for the engineer to explain. It concerns alternating-current systems only; operators of direct-current systems are to be congratulated that it does not add to their worries.

The importance of power factor correction to the industrial plant depends upon several factors, most important of which is the cost of power, followed by the voltage regulation of the system.

Power factor is expressed as a figure indicating the percentage of the apparent power in a circuit which will give the true or useful power. Consider the following instrument readings obtained on a single-phase, two-wire system: Amperes, 36; volts 220. Watts would then equal $36 \times 220 =$ 7,920, or 7.92 apparent kw. In a d.c. system this would equal the true or useful power available, but on an a.c. system having a power factor of 62 the true or useful power would be $E \times I \times p.f.$, or $220 \times 36 \times 62$ per cent = 4,910 watts or 4.91 kw.; this latter figure would be the one obtained from a wattmeter. Hence, the wattmeter is the proper measuring instrument for obtaining values of a.c. power, as it takes power factor into consideration.

In the above example the current was 36 amp. for a load of 4.91 kw., but with a power factor of 100 per cent this current would have been 22.32 amp., a saving of $36 - 22.32 =$ 13.68 amp. In other words, by increasing the power factor from 62 per cent to 100 per cent a saving of 13.68 amp. would be made. Low power factor is undesirable, then, because it increases the amount of current beyond that necessary for doing useful work. The lower the power factor the greater the amount of this extra, unnecessary current.

The current supplied to a.c. apparatus may be considered as consisting of two parts; one performs useful work in driving motors, etc., whereas the second current is used in energizing the magnetic field of the motors or other apparatus. In the case of d.c. apparatus the energy to supply the magnetic fields is furnished by the line, which merely supplies the relatively small current necessary to maintain the field constant.

With a.c. apparatus, however, the magnetic fields are magnetized in one direction and then de-magnetized and magnetized in the opposite direction and again de-magnetized during each cycle, or 60 times a second for a frequency of 60 cycles. The comparatively large amount of energy required is supplied by the generator during one portion of the cycle, and then returned to the generator during another portion of the cycle. This causes a continuous surge of current back and forth over the line and results in no useful work, as the current is simply borrowed and returned during each cycle.

The first or useful current multiplied by the voltage equals the true watts, whereas the second or unusable current multiplied by the voltage equals the so-called wattless power, which performs no useful work. The higher the power factor the lower the value of the wattless current.

Measurements taken by means of an ammeter, voltmeter, and wattmeter on a single-phase circuit supplying an induction motor, showed 220 volts, 20 amp., and 3,520 watts, respectively. Multiplying the amperes and volts together to obtain the watts, as with direct current, the total would be 4,400 apparent watts.

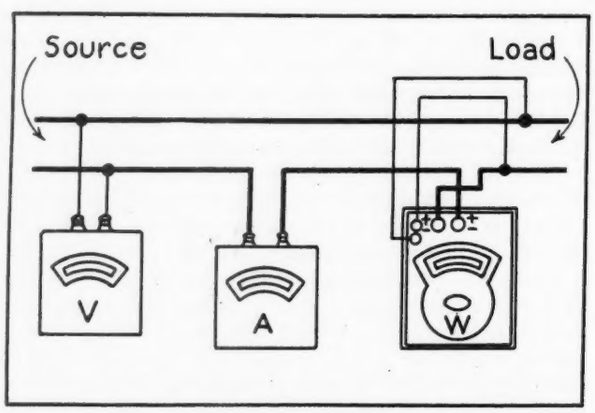


Fig. 1—Connect a voltmeter, ammeter, and wattmeter in this way for measuring power factor on a single-phase circuit.

The wattmeter, however, indicated only 3,520, which was the true watts actually taken by the motor. The ratio between these two figures equals the power factor: that is, $3,520 \div 4,400 = 80$ per cent, which was the power factor. The difference between these two figures is 880 volt-amperes, which

are an added and useless burden on the generating and distributing systems.

When the power factor is 100 per cent, or unity, we have reached the best operating condition, so far as power factor is concerned. When it reaches a value as low as 60 per cent it becomes serious, in most cases. A system having a power factor of 90 per cent is considered good, and there are few systems operating at much above this figure, except perhaps for lighting purposes only.

The greatest cause of low power factor in industrial plants is the induction motor, especially if underloaded. Induction furnaces, transformers, and other apparatus based upon electromagnetic action cause power factor to lag, the amount depending upon the amount of inductance. Incandescent lamps and other apparatus containing resistance only do not cause power factor either to lead or lag. Static condensers and over-excited synchronous motors cause leading power factor.

If a static condenser is connected into an a.c. circuit it is charged during one-half of the cycle and discharged during the other half-cycle and tends to lower the power factor as does magnetic apparatus. However, in the case of the condenser the power factor is "leading" and for this reason it may be used to offset the effects of lagging power factor caused by magnetic apparatus.

Looking at power factor from the financial standpoint a typical case is:

	Volts	Amperes	Load	P.F.
1.	556	254	130 K.W.	52
2.	562	180	130 K.W.	72

Thus a 74-amp. decrease in current was obtained by increasing the power factor from 52 to 72 per cent. This reduction in current, without changing the load, made a saving of $65 a year in the copper losses of the plant distributing system. This saving was calculated by multiplying the amperes, squared, by the resistance (0.25 ohm) of the circuit. Then $5{,}476 \times 0.25 = 1{,}369$ watts or 1.37 kw. The cost of power was 2 cents a kilowatt and on the basis of eight hours a day for 300 days, the cost would be $1.37 \times \$0.02 \times 8 \times 300 = \$65.76$ paid for losses.

In addition to the financial saving made, the regulation of the system was so improved that there was an increase of 6 volts at the transformers and 24 volts at the load.

The above saving was made by rearranging the induction motors in the plant.

Additional benefits were eventually obtained by the use of a gas-insulated static condenser which increased the power factor to 80 per cent.

Measurement of Power Factor

Power factor is the ratio of the true watts (as obtained by the wattmeter) to the apparent watts (as obtained by an ammeter and voltmeter). Thus, true watts divided by apparent watts equal power factor, all instruments being connected into the same circuit and simultaneous readings taken.

For single-phase systems a power factor meter may be used to give the results without calculations; it indicates at the same time whether the current is leading or lagging. In Fig. 1 is shown the connections for an ammeter, voltmeter, and wattmeter for power factor measurements. In this case wattmeter readings divided by (amperes times volts) equals power factor.

In a three-phase system the power factor may be obtained from the readings of two ammeters, a voltmeter, and one polyphase or two single-phase wattmeters connected as shown in Fig. 2. By properly connecting current and potential transformers to the circuits in Fig. 2, measurements may be made on high-voltage, polyphase circuits.

Two single-phase wattmeters con-

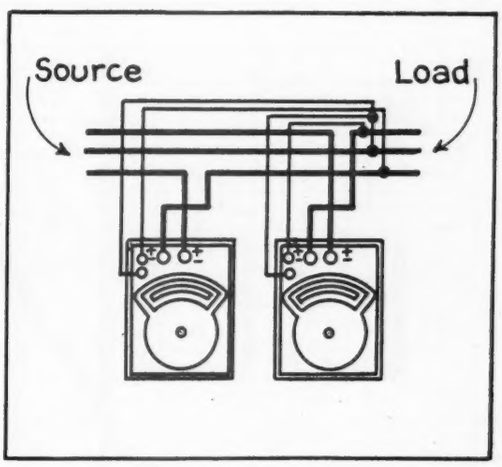


Fig. 3—Connections for measuring power factor on a balanced polyphase circuit, using two single-phase wattmeters.

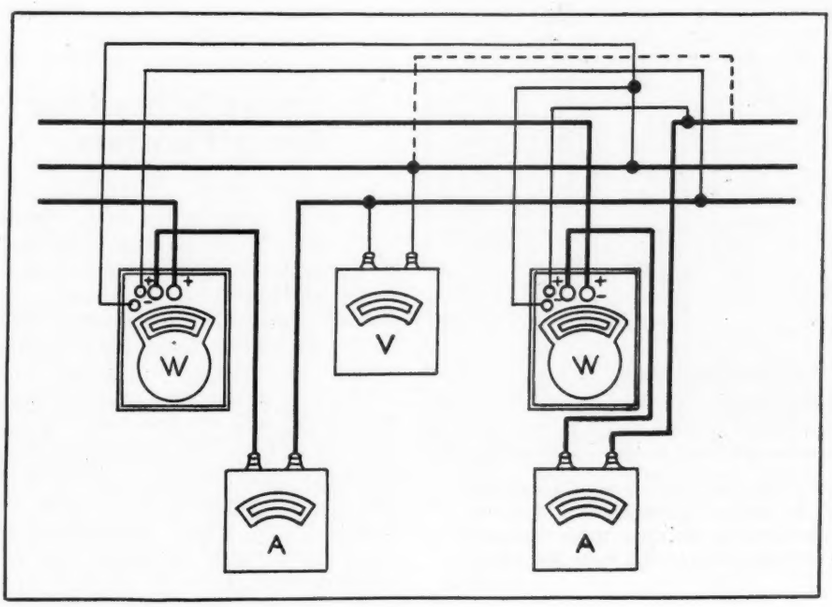


Fig. 2—For measuring power factor on a three-phase, three-wire circuit, the ammeters, single-phase wattmeters, and a voltmeter are connected as shown here.

nected as shown in Fig. 3 may be used for power factor determination on balanced polyphase circuits. First, take wattage readings in the circuit, making sure that the instruments are properly connected with respect to polarity. These polarities should be carefully followed to insure the proper relations between the currents in the current and potential coils of the wattmeter, or wattmeters.

If ϕ = the phase angle of the system
W_1 = the larger of the two wattmeter readings
W_2 = the smaller of the two wattmeter readings (with its sign)
Tangent $\phi = 1.732 \times (W_1 - W_2) \div (W_1 + W_2)$

From a table of cosines and tangents the cosine ϕ corresponding to tangent ϕ found above may be obtained, and is the power factor of the system. This method of computing the phase angle or power factor requires that the system be balanced. In practice, polyphase systems are only approximately balanced.

When using a polyphase wattmeter for measuring power factor, make sure that the polarities of the circuits are correct. The potential circuit of one phase is opened by removing the wire connected to its binding posts and a reading is taken; the wire is then replaced and the second wire, leading to the other potential circuit, is removed and a second reading is then taken.

These readings may be substituted in the formula given above, or the curve in Fig. 4 may be used. This curve gives the relation of the power factor to the ratio of the wattmeter readings; or Ratio $= W_2 \div W_1$, where W_2 is the smaller reading and W_1 the larger reading. Knowing the ratio of the smaller reading (with its proper sign), to the larger reading, the corresponding value of power factor may be found from the curve.

For example, let us assume that

Wattmeter reading $W_1 = 10.00$ kw.,
Wattmeter reading $W_2 = 6.50$ kw.
Ratio of wattmeter readings = $6.50 \div 10 = 0.65$

From the formula, cosine $\phi = 0.939$, representing a power factor of 93.9 per cent.

From the curve in Fig. 4, cosine $\phi = 0.937$, or a power factor of 93.7 per cent.

Again, suppose wattmeter reading $W_1 = 8.00$ kw. and wattmeter reading $W_2 = -2.00$ kw. (read by reversing current terminals).

Ratio of wattmeter readings = $-2.00 \div 8.00 = -0.25$.

From the formula, cosine $\phi = 0.327$, representing a power factor of 32.7 per cent.

From the curve in Fig. 4, cosine $\phi = 0.325$, or a power factor of 32.5 per cent.

In the above formula and table a sine wave is assumed.

The necessity of observing the sign of the smaller wattmeter reading comes about from the fact that when two single-phase wattmeters are used to measure power factor, one meter will indicate in the reverse (negative) direction when the power factor is less than 50 per cent. To obtain a reading, its current circuit must be reversed. If the power factor of the system is above 50 per cent both meters will give positive readings, but one will be greater than the other except when the power factor is unity on a balanced system: then the readings will be positive and equal.

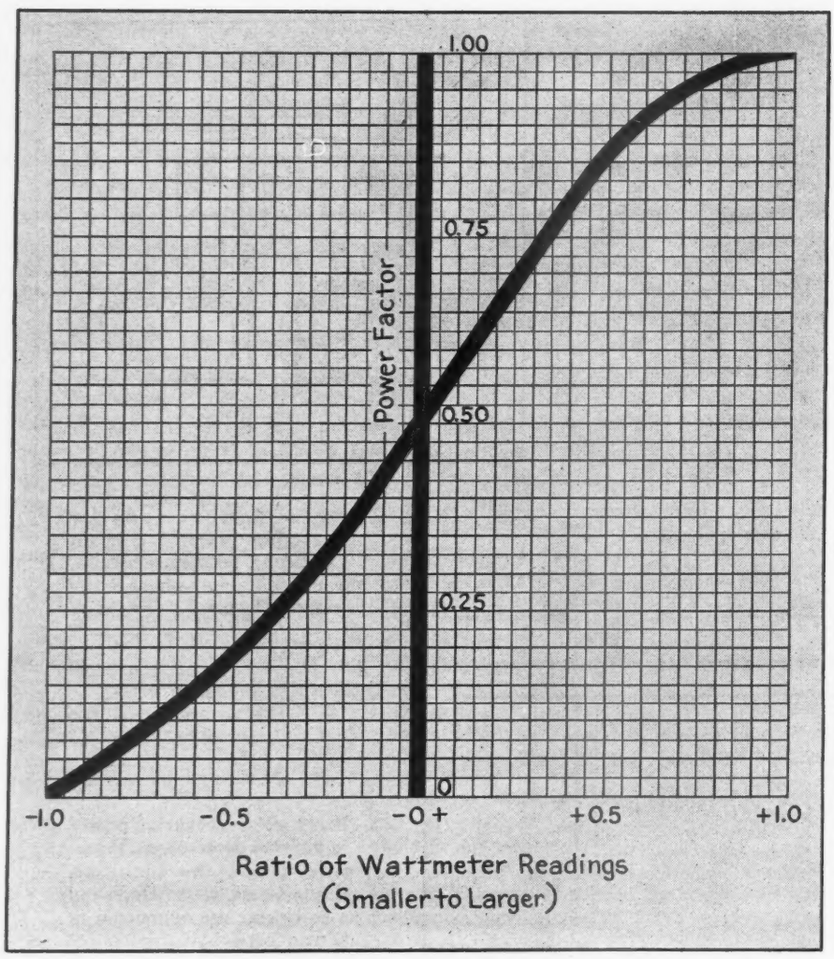


Fig. 4—Power factor may be determined from the ratio of the single-phase wattmeter readings (smaller to larger) by means of this chart. From the point on the bottom horizontal line representing the ratio, trace vertically upward to the point of intersection with the curve, and read the power factor directly.

Training School for Spray Painters

A FREE school, designed to instruct users in the care, operation, and use of its spray-painting and spray-finishing equipment, as well as the accepted methods of securing desired results, has been astablished by the DeVilbiss Company, Toledo, Ohio.

The first part of the course covers the mechanical features of spray painting and finishing equipment. The student is next taught to operate and service the equipment. Finally he specializes in actual spray-painting, spray-finishing, decorating, and refinishing work.

AROUND the WORKS

A section devoted to short articles describing practical methods devised to meet specific operating conditions. The items may refer to details of installation, inspection and testing for maintenance, wiring, repair, and replacement.

Zinc Blocks to Correct Corrosion in Tanks or Coolers

IN reading the article on this subject in the March issue of *Industrial Engineering*, it occurred to me that a more comprehensive explanation would benefit readers desiring to use this method.

Plates should be 98 per cent pure zinc, about ½ in. thick, and of a size to avoid waste in cutting. The size often used is 6x10 or 6x12 in. with a central hole of ¾-in. diameter for attachment to the stud which suspends the plate in the water. If more than one plate is used, separators between the plates will be required so that the water may have access to all surfaces. Exposure of 3 sq. in. of zinc surface for each 100 lb. of water in the tank is ordinarily sufficient. If it is desired to use zinc shavings they may be suspended in a perforated vessel. In either case the zinc must be suspended and connected in a manner that insures perfect electrical contact.

For the best effect the zinc should be near the incoming water-air to meet and neutralize the oxidizing effect when it is liberated.

The air entering with the water is a cause of corrosion which may be eliminated. Making sure that the end of the suction line is submerged sufficiently to prevent the pump from drawing in air accomplishes this purpose. If it ends a short distance beneath the surface the velocity of the water entering the pipe creates vortices which permit the air to be admitted.

The theory, on which the zinc acts to save the metal, is based on the fact that it is electro-positive as compared to iron. Therefore, when the zinc is immersed in a tank of water, a current is set up which flows from the zinc to the iron with the result that the zinc oxidizes and corrodes, and the iron does not. However, the zinc becomes electro-negative to iron when sufficient zinc-oxide adheres to it. In this case the current is reversed and the iron corrodes faster than if there were no zinc present. Hence, to prevent reversal of the desired action, the zinc must be kept clean and free from oxide.

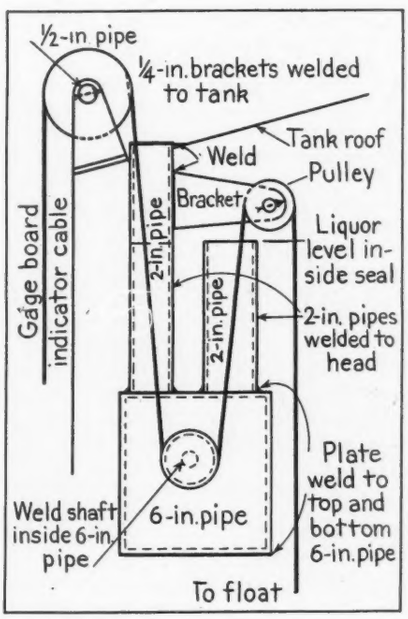
Sea water near large cities contains a larger percentage of foreign matter which it is difficult to remove with foot-valve strainers. Consequently, this suspended matter is constantly coming into contact with the zinc. If this be the case the zinc will require cleaning or replacement at more frequent intervals than otherwise.

WILLIAM ANDERSON.
E. W. Bliss Company
Brooklyn, N. Y.

Liquid Seal for Gage-Board Cable

WHERE a gage board is used on a tank that contains gasoline or other vapor-giving liquors, a seal is needed where the cable comes out of the tank roof.

A very simple and efficient type can be made from a piece of 6-in. pipe about 8 in. long. In the bottom a plate is welded as shown. Inside this section of pipe a small grooved pulley is mounted on a shaft; the shaft being welded on the inside of the pipe. Two pieces of 2-in. pipe are welded into a head for this section; one piece about 12 in. long, the shorter one 6 in. long. The cable is threaded through the pulley and through the two pieces of pipe. The head is then welded into the 6-in. reservoir.



Liquid seal fabricated from pipe sections.

On the longer piece of 12-in. pipe another pulley is mounted on a bracket and welded, as shown. A hole is cut in the tank roof and the 2-in. pipe, 12 in. long, is welded in so that it just projects above the roof.

An outside bracket is then made from two pieces of ¼-in. plate, flanged on one side and welded to the tank. The cable is then threaded through the pulleys, one end is attached to the float and the other end to the gage-board indicator.

On filling the tank to capacity the liquid enters the smaller of the 2-in. pipes and fills the reservoir making a seal through which no vapors can escape to the atmosphere.

If it is not feasible to first fill the tank the reservoir may be filled from the tank roof with oil or other liquid, preferably the former, as it tends to lubricate the pulleys.

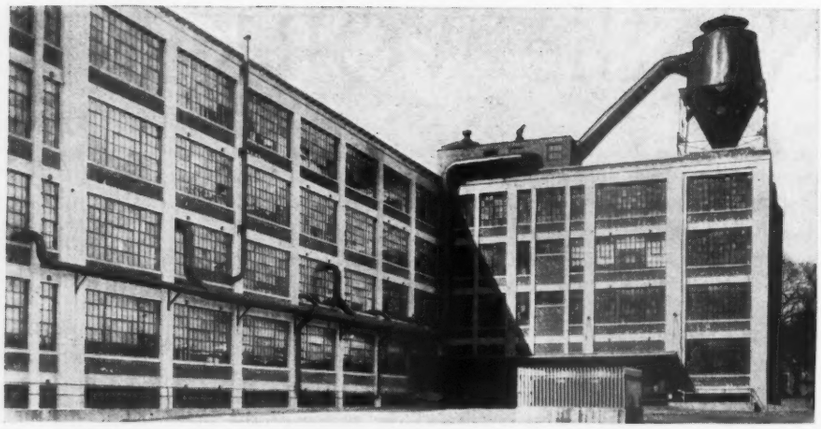
If welding is not permissible this assembly can be made up using threaded nipples and other accessories to insure a liquid-tight compartment.

M. C. COCKSHOTT.
Long Beach, Calif.

Exterior Piped Dust System Has Many Advantages

CONSIDERABLE practical experience is required in the design and construction of a dust collecting system for a factory because of the practical problems involved in the operation of such apparatus.

From my experience with the various classes of equipment, namely; *(a)* the installation of the individual dust collecting system to a separate machine, which operates as a part of and is attached to the production machine; *(b)* the location of a central unit embodying the collection of dust from a group of machines into one large equipment; *(c)* the segregation of machines into a small group and the installation of several small dust collecting systems for



Installing the greater portion of the dust collecting system on the exterior of the building provides for greater freedom inside, increases the infiltration of daylight illumination, and localizes the fire hazard on the outside.

their use, each having its practical application and operating advantages.

An accompanying illustration shows a large centralized system which serves a shoe factory 400 ft. long, 60 ft. wide, and four stories and a basement in height. This system is powered by a 100-hp. synchronous motor. The low-speed exhauster discharges into a large collector located on the roof, as shown. The synchronous motor was used as a means of improving power factor conditions for the entire factory inasmuch as the fan is operating at constant speed and load eight hours a day.

There are several methods of locating the main piping in a dust collecting system. The one shown carries all the main piping on the outside of the building, thereby leaving the interior of the building free from obstructions.

It was found to be easier to install the piping in this manner, as the path was free from the usual obstructions that are always present in the interior of a building. All piping, and apparatus with its attendant fire hazard were brought to the exterior. We know from experience that fires occur on the inside of dust collecting systems, which are caused by inflammable materials collecting at the elbows, joints and outlets, and ignited by sparks or other causes. As a result clean-outs were provided at frequent intervals, so that fire-fighting apparatus may be inserted in the emergency.

All connections to the production machines were made through the windows. Locating the collector proper depended upon local conditions, but sufficient elevation was practical to enable it to discharge to a dust house after the material in suspension had been separated from the air.

At the various machines the suction varies with the kind of material conveyed, but for our purpose 2½- or 3-in. water gage has been found ample to provide for adequate dust removal.

All piping was laid out to provide for at least 25 per cent additional capacity and to take care of incipient air leakage.

Because this equipment is located on the exterior of the building it was thoroughly painted, and all the joints carefully soldered to prevent water from entering and clogging the line.

One of the most important reasons for placing the piping on the exterior of the building was to admit as much light to the factory as possible. This equipment installation has proven satisfactory, and I believe that it is the most progressive method of handling a problem of this kind.

K. D. HAMILTON.
Mechanical Department
Geo. E. Keith Company
Campello, Brockton, Mass.

■

How to Erase Lines from Vellum Paper

VELLUM paper for making pencil drawings is widely used in drafting rooms because it does not shrink like the average tracing paper, neither does it deteriorate as rapidly. A fair print can be obtained without inking the drawing.

It has some disadvantages. One is that it creases badly and such creasing shows up on the blueprint as lines which may be mistaken as a part of the drawing thus bringing into the picture considerable chances for error. Vellum tracings handled frequently become full of creases and cracks making it necessary to do something about their condition.

To remove such creases from vellum tracings, that is, effectively covering them up so that the resulting blue print will be as clear as a blue print could be, is an easy matter. The process is to lay the tracing on a flat surface, reverse side uppermost, and then just lightly paint the creased spots with castor oil using a soft brush for the purpose. Leave the oil on the paper for a few seconds and then wipe it off with a clean rag. The creases will be erased sufficiently to permit blue printing without their showing. If the oil is left too long on the paper it is apt to soak through. The same procedure may be followed with spots produced by erasing lines which often show faintly on a blue print.

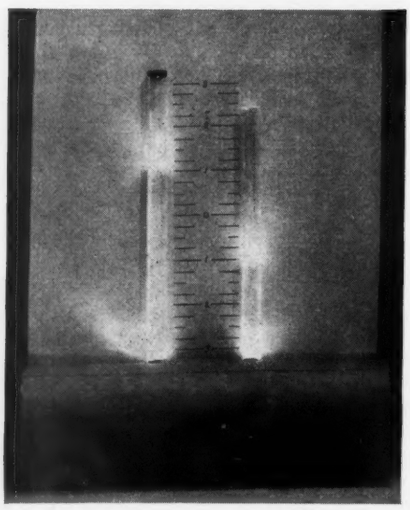
Waterloo, Iowa H. C. CHARLES.

■

Lighting the Manometer for Easy Reading

READING manometers is not as easy as it seems, particularly those that are filled with a light colorless liquid. Operators quite frequently experience difficulty in seeing the water level which designates the tank pressure, or fluid level, if the instrument happens to be the single tube variety used on fluid tanks.

The device shown in the illustration is simple, easy to make, and works. It consists of a sheet-metal housing (any



other type will do) built around the U-shaped tube in which is inserted a 25-watt T-6½ lamp. The entire tube is lighted and, as the meniscus of the liquid produces a lens effect, a source of light is obtained at the water level, making the manometer easily readable at a distance of several feet.

■

Coded Pipes and Conduits Lessen Plant Hazards

IN the absence of a standard color scheme for the identification of pipes and conduits carrying the plant's various services, more or less originality must be displayed by the personnel in establishing a scheme of their own.

PIPES USED FOR	PIPES PAINTED	FITTINGS PAINTED
STEAM—High pressure	Aluminum	Red
Low pressure	Aluminum	Black
H.P. return	Aluminum	Aluminum
L.P. return	Aluminum	Yellow
HOT WATER	Aluminum	Dark Blue
COLD WATER	Dark Blue	Dark Blue
FUEL GAS	Yellow	Yellow
GASOLINE	Red	White
KEROSENE	Green	Red
LACQUER THINNER	White	Red
COMPRESSED AIR	Light Blue	Light Blue
DRAINS and SUMPS	Dark Green	Dark Green
AUTOMATIC SPRINKLERS	Vermilion	Vermilion
ELECTRICAL CONDUITS	Black	Black
FUEL OIL—Supply	Green	White
Return	Green	Yellow
LUBRICATING OIL	Green	Black
MOTOR OIL—Supply	Yellow	White
Return	Yellow	Blue
Dirty	Yellow	Brown
TRANSMISSION OIL—Supply	Black	White
Return	Black	Yellow

While the idea is not new it is practical, and, with little effort a color selection is possible, which if instituted and maintained will prove to be a time saver for the maintenance crew and a safety measure to other employees as well. There is, however, always the possibility of overdoing it. Nevertheless, any scheme would be better than none at all if it tended to obviate instances similar to the following: A welder played his acetylene torch on what he supposed was a leaking water line only to find out that it contained gasoline.

Another employee clutched a pipe to pull himself upon a ledge, burning both hands. The pipe carried high-pressure steam.

Knowledge by employees of the contents according to the color of the carrier would have prevented the foregoing accidents.

Color codes corresponding to the scheme outlined for a large plant, if posted in conspicuous places for employee use and reference, will tend to obviate similar occurrences.

Pontiac, Mich. R. W. SPEARS.

■

Reclaiming Waste Lacquer

IN the process of spray coating from 20 to 60 per cent of the material, depending on the size and shape of the part coated, is wasted. At the National Cash Register Company's plant, Dayton, Ohio, a considerable proportion of this waste material is reclaimed at about one-third the cost of new material.

When shellac was sprayed, the dried waste was removed from the booth and cut with the proper amount of alcohol to suit the material to its use. With the advent of lacquer a more elaborate procedure became necessary.

The spray booth used is worthy of note because its action differs from general practice. The booth is located in an inclosed spray room in which a sufficient pressure of clean air is maintained to prevent the entry of dust from the shop and at the same time to cause the movement of air out through the spray booths.

The exhaust air is cleaned by means of excelsior pads clamped between two layers of steel wire netting fastened to frames. These screens can be removed easily, the clamps loosened, and the pads replaced. No attempt is made to salvage the material collected by these pads.

Below the conveyor which carries the parts to be coated is a shelf designed to catch most of the waste. This shelf is coated with vaseline and covered with heavy paper. The upper surface of the paper, as well as other surfaces of the booth, are sprayed with a thin, even coat of warm vaseline, to prevent the lacquer from sticking.

Twice daily the accumulation is gathered from these surfaces and taken to the laboratory where the reclaiming is done.

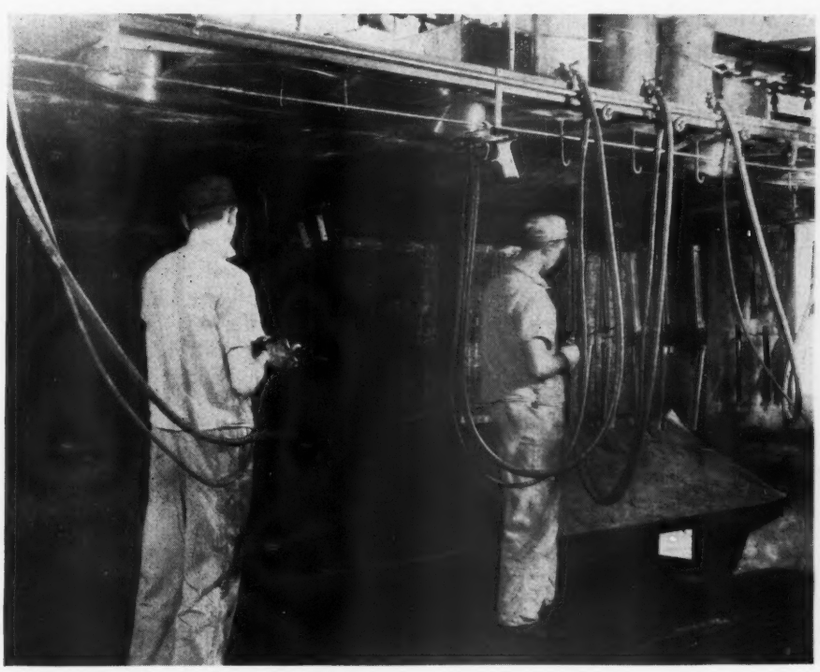
The lacquer is first put into a tumbling barrel with a predetermined amount of benzine, the quantity depending upon the vaseline content of the waste. The tumbling continues from 16 to 24 hours or until all the vaseline has been dissolved by the benzine.

When the "wash-out" is completed the benzine and vaseline mixture is drawn off, the proper proportion of ethyl acitate and butyl acitate is added, and the tumbling is continued until the lacquer has been thoroughly and completely dissolved.

The kind and quantity of thinners desired is determined by a competent chemist, as a different product is required for each class of work.

The solution is then passed through a centrifuge to remove all dirt and suspended matter, after which the material is ready for use.

This recovery process, which nets at least 400 gal. a month, requires but a small portion of the time of the three or four men employed in the laboratory. The equipment is very simple and such as any large plant might require for other work.



The spray booth offers large surfaces upon which the waste accumulates. Quickly detachable screens are also a feature.

Details of the Plant Shown on the Cover

PLANT engineering in the works of the Kearney & Trecker Corporation, Milwaukee, Wis., manufacturers of machines for milling metal, whose plant is illustrated on the cover, is under the direction of the works manager. Included as parts of the function are electrical maintenance, mechanical maintenance, and the maintenance of buildings. Reporting directly to the works manager are the superintendent, production manager, plant engineer, electrical engineer, and maintenance engineer. Maintenance work is handled by 25 employees, with auxiliary forces drawn from the productive help when extraordinary load requires. Under normal conditions, for example, in 1929, there are 800 employees in the shops.

Two-thirds of the electrical energy for power and light is generated, and the other third is purchased. Connected motor load totals 1,450 kw., and total lighting load is 168 kw. Group drive motors account for 225 hp., and individual drive motors, 1,575 hp. Equipment for lighting shops and office consists of:

33 750-watt lamps
82 500-watt lamps
105 300-watt lamps
169 200-watt lamps
8 150-watt lamps
81 100-watt lamps
552 50-watt lamps

Steam is used to provide heat both by direct radiation, and by means of unit heaters. Part of the main plant is heated by means of tunnels with blower and heater connected.

The inventory of cranes is as follows:

2 3-ton, 3-way cranes
8 5-ton, 3-way cranes
2 10-ton, 3-way cranes
2 ½-ton hand traveling-electric hoist
4 1½-ton hand traveling-electric hoist
7 2-ton hand traveling-electric hoist
1 3-ton hand traveling-electric hoist
3 1-ton hand traveling-chain hoist
4 1½-ton hand traveling-chain hoist
2 2-ton hand traveling-chain hoist
2 3-ton hand traveling-chain hoist
13 Miscellaneous, consisting of air, chain, post, trolley, bridge, and portable.

Materials handling equipment includes:

1 3-ton lift truck
1 1-ton lift truck
550 Truck platforms
115 Platform boxes
30 Stake trucks
20 Warehouse trucks
12 Wheelbarrows
20 Lift-truck stake platforms
5 Rack trucks
1 Concrete cart
10 1¼-ton hand lift trucks
2 2½-ton hand lift trucks
1 3-wheel wagon truck
2 10-ton trucks
1 Steel dump cart
1 Gasoline truck tractor, 20-hp.
3 4-ton trailers
1 Snow plow
1 30-cu. ft. chip trailer
5 Chip pan trucks

There are in addition one 5-ton, one 3-ton, and one ¼-ton gasoline motor trucks, and one utility passenger car for the transportation of guests and for miscellaneous use.

Plant No. 1 houses one of the machine shops and the erecting shop. It is of single-story, saw-tooth brick and steel construction and contains 117,000 sq. ft. of floor space.

Plant No. 2 houses one of the machine shops and the pattern shop. It is a combination one- and two-story building of brick, steel, and glass, and contains 33,500 sq. ft. of floor space.

The office, with 20,500 sq. ft., is of three-story brick, steel-frame, and wood construction.

A two-story frame building of 2,000 sq. ft. houses the power generating equipment.

A brick and steel building of 4,700 sq. ft. contains the boilers and compressor units.

Heat-treating is carried on in a separate single-story, monitor-type, brick and steel building of 3,700 sq. ft.

Raw materials are allotted 6,000 sq. ft. in a one-story steel-frame, metal-clad building.

The one-story brick and steel garage has 7,000 sq. feet.

670 sq. ft. are provided for the laboratory in a one-story, flat-deck, brick and wood building.

Miscellaneous buildings include two gate houses, a pump house, a tank house, and buildings for oil and paint storage.

Total floor space is approximately 200,000 sq. feet.

Several types of roofs are represented: 4-ply composition; 4-ply tar and gravel; 4-ply built-up; composition and shingle; and corrugated galvanized iron.

Plant No. 1 has a floor with 5-in. concrete base, tar-mopped, covered with tar-mopped wool felt, surfaced with ⅞x3½-in. maple laid on 2x12-in. pin stringers. Plant No. 2 has a 5-in. concrete floor consisting of 4 in. of concrete and 1 in. of cement finish.

Five trunk lines of the Bell telephone system with 48 extensions provide communication. There is also an automatic call system.

Three railroad sidings from the Belt Line provide transportation for incoming materials and equipment, and outgoing shipments.

■

Third National Industrial Equipment Exposition Announced for 1932

AT THE conclusion of the Second National Industrial Equipment Exposition held in Cleveland last month the management of the exposition made the following announcement: "Encouraged by the success of the second exposition, the Midwestern Exposition Company announces that the Third National Industrial Equipment Exposition, featuring Management, Maintenance, and Materials Handling will be held in April, 1932. A survey now being made will determine the location.

"The first exposition was held in Chicago and the second in Cleveland. At the latter nearly 30,000 sq.ft. of the Public Auditorium were occupied by more than 100 exhibitors. In spite of existing business conditions, attendance was particularly satisfactory from the standpoint of quality and enthusiasm. The Third National Industrial Congress will be held coincident with the next exposition."

Maintenance Doctors

FREDERICK SEIBEL, Jr.
Venino Bros. & Company, Inc.
Newark, N. J.

THE cost of systematic attention to electrical equipment is the price of continuity of power service, and is effective, if not perfect, insurance against the costly repair bills that follow serious breakdown.

Most large industrial plants have in operation enough equipment to make it necessary and economical to maintain their own force of expert inspectors and repair men. What about the plants having only small horsepower requirements, and consequently, a limited number of motors and other electrical equipment? The need for competent inspection and repair of the electrical equipment is just as important as in a large plant, but the cost of keeping on the payroll one or more repairmen of the requisite skill and experience may not be warranted by the amount of work to be done. One solution of this problem lies in the service obtainable from commercial maintenance organizations—maintenance doctors.

The company with which I am associated was formed nearly 35 years ago and, as one branch of its business, has for many years been servicing the electrical equipment in a large number of plants in and around Newark, N. J. Some of the things we have learned about how the inspection and servicing of industrial equipment can best be handled will be of value to other readers.

Maintenance service is handled under a variety of contract forms. One of the broadest forms, which was quite popular some years ago and doubtless still is offered by some maintenance companies, specifies in effect that for a certain consideration inspections will be made, lubrication service rendered, and any repair work done that may be necessary to keep the motors running.

From the standpoint of the industrial plant this may be a very desirable arrangement, but it is likely to be risky in the extreme for the maintenance company. For example, there is nothing except native honesty to prevent the owner from overloading or abusing his motors in every way possible, and then when breakdowns or burnouts occur, insisting that the damage be repaired under the terms of the contract.

A commercial service organization that maintains electrical equipment in plants that cannot do their own servicing economically.

There have been instances where a plant full of motors that were in deplorable shape from neglect and abuse has been covered by such a contract. The result was, of course, that the maintenance company was quickly saddled with the job of rewinding a large number of motors—for a compensation that was not much more than enough to cover inspection and simple maintenance service.

On the other hand, if the rates for such a contract are made high enough to cover the contingency mentioned before, the industrial plant with good equipment and fair-minded management is likely to be unjustly penalized by having to pay a higher price than is warranted by the service required.

Under other forms of contract or agreement, the customer purchases certain services at a flat rate: That is, motors or other equipment will be inspected once every two weeks, once a week, or oftener, for a stated sum. Other services—lubrication, cleaning, testing, and so on—are rendered, if desired, on the payment of additional fees, which are based on the amount of work involved, the frequency with which the work is done, cost of materials used, and other factors.

In making the foregoing statements there is no desire to criticize anyone who desires to render or purchase maintenance service under the forms of agreements described. If they accomplish their intended purpose to the mutual satisfaction of the parties concerned, there is no room for criticism and no need for defense.

Our own experience over a long period of years has demonstrated, however, that it is extremely difficult to make a formal contract for the various kinds of maintenance service that may be required on a basis that is fair to both parties and will avoid the likelihood of misunderstanding and dispute. Local conditions and service requirements—to say nothing of the nature and age of the equipment—vary so much in industrial plants that disagreement over the letter and spirit of a contract may easily arise.

To simplify matters, we offer our industrial maintenance service on a straight time and material basis, without a formal contract. Thus, when an industrial plant engages us to take care of the electrical equipment, we reach an agreement with the plant representative as to the needed or de-

sired frequency of inspection, the most convenient day and hour for doing the work, and so on. With these details out of the way, our service man, or men, visit that plant on the days and at the hours agreed on, and inspect all motors, controls, and other electrical apparatus. Oil wells are drained and refilled at such intervals as may be dictated by the service conditions. Contact-making parts are cleaned and polished and, in brief, all equipment is gone over with sufficient care to determine its exact condition.

Any needed adjustment or repairs that can be handled on the job are made by the service man. When he leaves the plant he presents for the signature of the customer the maintenance time sheet shown in one of the illustrations. The customer then has an opportunity of knowing just what work was done, and how much time was required to do it. He knows, too, that he will be billed for this service at the rate of $2.50 an hour for the inspection, and $1.50 an hour for a helper, if one is needed, with an additional charge for materials used.

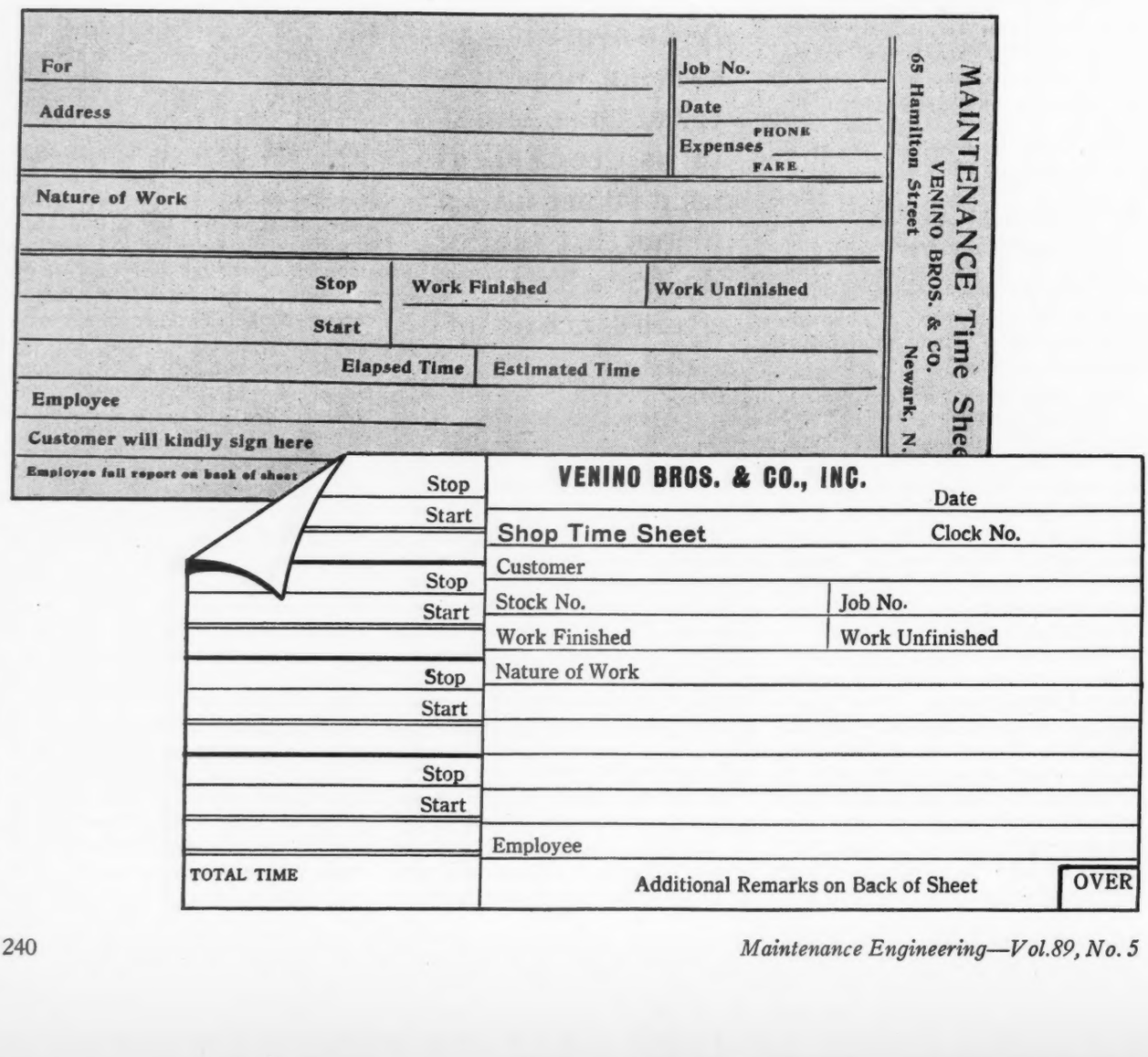
If the inspector's examination shows that repair or other work which will run into any considerable sum is needed, or which cannot be done on the job, the customer is notified. If he wishes to disregard our recommendations, he is at liberty to do so; if he wishes to have some one else do the work, that also is his privilege. Almost invariably, of course, we are asked to give an estimate on the cost of the work; if our proposal is accepted, the whole matter is handled as a separate transaction, and the customer is billed on the basis of the time and material used on the job.

Assuming that a motor has to be removed to our shop for repairs, we will if desired furnish and install another motor in its place. The minimum rental charge for any small motor is $7.50 a month. Rental charges, of course, are based on a sliding scale which approximates $1 a month per horsepower for the larger sizes. No motor is rented for less than a month, and the customer is billed for transportation and installation charges.

Whatever may be the shortcomings of our method of handling maintenance service, it has at least the advantage that the customer knows exactly what services have been rendered for him, and pays only for those services, upon receipt of a monthly statement. If a customer requires additional inspection and maintenance service at any time, or wishes to discontinue our maintenance service, there are no formalities to be ob-

When a service man leaves the plant of a customer he presents this time sheet for signature. The customer is thus given an opportunity to learn what work has been done and the time required, status of the work, if unfinished, and an estimate of the time required to complete it.

Shop Time Sheet. Before starting work on any job, the shop men fill out this sheet and keep a record of all time spent on the job. A separate sheet is used for each job.



Receiving Dep't. VENINO BROS. & CO., INC. 65 HAMILTON STREET NEWARK, N. J № 10600

Date_____

Name
Address
City State

MOTOR DATA

Maker
Serial No. Shop No.
H. P. Volts Ph. Cyc.
R. P. M. Type
Amp. Rating Style No.
Frame Model Form
Slip Ring Repulsion Induction: Size
New Old A. C. D. C.

OFFICE DATA

Exch. No. Order No. Call Slip No.
Repair Credit
Estimate Charge No.

Pulley Data
Kind Dia. Face Bore

Base Data
Kind No. Size

Rails Data

Starter Data H. P
Maker Volts Ph. Cyc.

Type Serial No.

Grid Data

Controller Data

Cost

RECEIVING DEP'T. DATA—SHIPMENT CONTAINED

Motors Pulleys Base & Rails Oil Starter Grids Controller Rheostat

Via Ex. Chge. Job No.
Remarks

Checked by

Receiving Department Form. As soon as a motor comes into the shop for repairs this form is filled out and sent to the office. An identification tag bearing the job number is made out at the same time and attached to the motor.

served. A telephone call or a letter will serve to indicate his wishes.

We also are prepared to give whatever consulting engineering service that a customer or any one else may require. We will make whatever surveys or studies are needed, and prepare plans and cost estimates on any electrical work that an industrial plant may need. A charge is made for all such services.

If our proposals and recommendations are accepted, we will sell the customer and install whatever equipment is needed—new or rebuilt, just as he prefers. Or if he prefers to purchase his own equipment, we will install it for him. As an adjunct to both our maintenance and engineering services, we carry a stock of several thousand rebuilt motors and control equipment of all types and up to several hundred horsepower rating, as well as new pulleys, chain drives, motor bases, and other accessories. New motors and controls can be furnished when desired.

Motor repairing and rebuilding is an essential and large element of our business. For this work we maintain two well-equipped repair shops, one at our main plant and the other in the warehouse in which we keep our stock of motors.

When a motor, say, comes in for repairs it is given a job number, and the nameplate and other data are entered on the receiving department form. It is then sent either to the testing department, or one of the workmen is assigned to make a detailed examination to determine what repairs are needed to put the machine in first-class condition. If an estimate of the cost has been requested, or if the amount is large enough to make consultation with the customer desirable, he is informed of the nature of the repairs necessary and the cost of making them. With motors as cheap as they are today, it is necessary to keep in mind the question of whether a motor is worth rewinding or costly repairs. With old-type designs, the cost of extensive repairs may be more than the market value of the motor.

If it is decided to rewind the motor, it then goes to the dismantling bench where the old winding is stripped out and the rewinding data taken. The coil data are sent to the winding department on the second floor of the repair shop, where the new coils are wound, formed, and taped by machine In the meantime, any needed mechanical repairs, such as replacement of bearings, are made on the motor.

Coils are put in in the winding department on the first floor. When the details of connecting the coils and testing have been completed, the motor is dried out for several hours at a temperature of 150 deg. F., and then dipped, while hot, in clear baking varnish. This is followed by a minimum of eight hours' baking at 225 deg. F. Larger motors are baked for somewhat longer periods.

After assembly, the motor or other equipment is checked at the bench by the winder and then sent to the testing department, where it is thoroughly tested while running light and under load. If it passes these tests satisfactorily, it is given a running test of a day's duration to make sure that bearings and other parts are functioning properly. All of our work is guaranteed for one year.

It is hardly possible to go into the details of our cost system here. Nevertheless, we have worked out a simple, but effective system that enables us to determine exactly the cost of any operation. When the workman starts on a job he fills out and stamps the starting time on the shop time sheet. Upon finishing his part of the job, or if he is interrupted, he stamps on the card the time of stopping work. In this way we obtain an accurate record of the time spent by every man who works on a given job, as well as a complete record of each man's activities over the entire day. All materials and supplies are withdrawn from stock on a simple requisition form which shows the job number against which the materials should be charged. This form must be OK'd by the foreman, who can thus control withdrawals and prevent waste.

The time sheets and material requisition forms are eventually sent to the accounting department, and all charges are placed against the proper job number on a cost data form. After the job has been shipped and a statement rendered all time and material sheets, and other records are permanently filed together.

MAINTENANCE ENGINEERING

L. C. MORROW, *Editor*

Vol. 89 MAY, 1931 No. 5

As Your Editor Saw the Maintenance Sessions

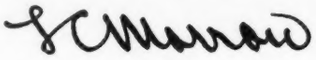
IT IS with much satisfaction that I report three successful Maintenance Sessions at the Second National Industrial Congress at Cleveland last month. A great stride was taken in extending recognition of and building prestige for the function of maintenance engineering in industrial plants.

I regret that it was not possible for all of the readers of *Maintenance Engineering* to be at the maintenance sessions. Many of them would have been inspired, as I was, by the caliber of the men now responsible for maintenance; by the keen discussion of both fundamental principles and details of maintenance problems; and by the obvious belief in the possibilities of great savings in maintenance activities, as indicated by the interest shown in the subject of wage incentives as applied to the function. Furthermore, throughout the meeting there was evident a recognition of maintenance engineering as a function of primary importance with which men are proud to be allied.

When the gavel tapped to open the first maintenance session in Chicago last year it was evident that maintenance engineers would attend meetings to discuss their problems. That the attendance at the Cleveland sessions during this year of depression averaged 100 is proof that the meeting at Chicago was not a flash in the pan. During a prosperous year the attendance should be trebled. I hope that 1932 proves to be such a year that we may have the opportunity for a third meeting of maintenance engineers. I promise my active support and the support of the staff of *Maintenance Engineering* in organizing and conducting the maintenance sessions.

And I now take the liberty of representing the maintenance engineers as a whole, and of publicly thanking, in their behalf, all of the men who in any way participated in the maintenance sessions at Cleveland, with special mention of these men, who gave of their time and energy, either in preparing and presenting the papers, or in presiding at the meetings:

HARRY W. BENTON, plant engineer, Pratt and Whitney Company; E. C. BRANDT, assistant works manager, Westinghouse Electric & Manufacturing Company; AUGUST HECKMAN, superintendent buildings, light, heat and power, Westinghouse Electric & Manufacturing Company; THOMAS A. KEEFER, head factory layout department, National Cash Register Company; T. J. MALONEY, New Jersey Zinc Company; G. I. ROSS, chief engineer, MacDonald Bros., Inc.; R. C. SMITH, illumination standards department, Western Electric Company; E. V. STOODY, assistant to the president, MacDonald Bros., Inc.; WALTER STURROCK, illuminating engineer, Nela Park Engineering Department, General Electric Company; W. G. UHLIR, consulting engineer, Harvey, Illinois; ALFRED VAKSDAL, plant engineer, Corning Glass Works; ROBERT W. WALTON, head service department, Shepard-Niles Crane & Hoist Corporation; SIDNEY WATKINS, chief electrician, Warner & Swasey Company.



A "Preventive Maintenance" Endorsement by New England

SEVEN hundred and thirty-nine executives, asked by the Industrial Committee of the New England Council what should be the working program for 1931, made fourteen major recommendations. Three of the fourteen, if carried out in plants now merely marking time, mean renewed activities in maintenance departments. They are:

"Develop plant modernization," recommended by 35 per cent. Includes recommendation for intensive study of materials-handling equipment, modern service equipment, modern power and lighting installations; and alteration or expansion of buildings and structures.

"Overhaul machinery and equipment," recommended by 41 per cent. Includes statement that once back in shape the equipment should be kept in condition by an "adequate maintenance program that forestalls breakdowns and minimizes repairs."

"Clean up, paint, repair, and do general house cleaning," recommended by 48 per cent.

Readers of *Maintenance Engineering* will recognize in these three recommendations the same advice that was given more than a year ago in this publication, and repeated many times since. The advice is just as sound now as it was then. We still have the period of volume of production ahead of us, and we must be ready to meet it. Many plants have completed their get-ready programs; others still have the job to do.

That so many of the executives included among their recommendations the three concerning main-

tenance activities augurs well for New England's appreciation of the important place of the maintenance function. The endorsement of preventive maintenance will be especially gratifying to all who recognize its cost-cutting potentialities.

Trying for This Award?

ANNOUNCED on another page of this issue is an award to be given for the best suggestion on any phase of waste elimination in industry.

Why shouldn't a maintenance engineer receive this award? And for a suggestion as to waste elimination in the work involved by the function of maintenance?

Much money is spent for maintenance. Where expenditures are large opportunities for savings are great. If the same performance can be secured with reduced expenditure the difference between the two amounts is waste.

And savings are being made in maintenance work. There recently came to the attention of your editor an instance of a company's setting out to save money without impairing results. It began with its production activities, naturally. Little opportunity was found for savings, however, so maintenance was tackled, and there opportunities for real savings were found. It's obvious that what can be done in one plant can be done in others.

Here's hoping that a goodly number of *Maintenance Enginering's* readers will go after that award—and that one of them will get it.

Will Your Portable Tools Stand 500 Volts to Ground?

THAT defective, electrically driven hand tools—drills, saws, hammers and the like—are dangerous to the operator needs little proof. Grounded windings, abraded cords, or worn switches introduce a very real hazard, unless the tool is properly grounded—something which it is not always convenient to do, nor easy to enforce. Ordinarily it is considered that 110 volts is nothing to worry about. Possibly not, if the contact with ground or line is of sufficiently high resistance to limit the current flow to almost nothing. With a good contact, such as may obtain when one is standing on a metal floor or is in intimate contact with any well-grounded structure, the situation is entirely different. Furthermore, the muscular reaction induced by an unexpected or severe shock must always be reckoned with. Injuries caused by falling or being "thrown" may easily be more severe than those caused by the shock itself.

At best, portable electric tools are subjected to rough service, not to say abuse, and it is to be expected that weak spots occasionally will develop. As a safety measure, the electrical department in one large plant recently adopted the practice of carefully inspecting all electric tools once or twice a month, and applying 500 volts to ground for one minute.

Perhaps better ways of testing portable tools have been devised by other readers; if so, the editors will be glad to learn the details. In any case, the simple ground test mentioned above is easy to make, and is commended to the attention of plant men who are interested in keeping their equipment in proper condition and furthering the safety of their employees.

To Repair of Doorbell . . . $20,000

ERRORS in transmitting part or order numbers probably are few in proportion to total number of orders involved. However, some of the errors are responsible for serious results.

There is the example of an order placed for a quantity of small parts which resulted in the customer's receiving a carload of switchboard panels. The last figure of the part order number was given wrong.

Another example involved no financial loss to anyone but did involve the accounting department in a ludicrous situation. An employee had lost a leg while engaged at his employment. As part of its considerate treatment of the man his company provided a wooden leg and set up an account against which its maintenance was charged. For several years things went well, until it was discovered that a carload of brick had been charged to maintenance of the unfortunate's peg leg.

A third example brings to light a mixup of maintenance and accounting order numbers which resulted in a charge of $20,000 for repairing a doorbell and a charge of $2 for rebuilding a water tank of great capacity.

The examples cited were reported by responsible men as actual occurrences. The errors were made in plants that are recognized as well-conducted units of industry. Similar errors can happen in any plant. So it behooves every individual to exercise great care in reading and copying order and part numbers. When possible additional information should be given to insure against errors, such as weight of part, sketch to show appearance, or description. When account numbers are involved identifying or classifying letters are almost a necessity.

Building Inspection and Maintenance—

WHEN? HOW?

K. D. HAMILTON
Mechanical Department, Geo. E. Keith Company
Campello, Brockton, Mass.

IF production machines break down they must be repaired or the plant will cease to function. But if roofs leak, floors are uneven, or heat is inadequate, the plant still can operate—even though under handicap.

This fact creates a tendency to cut maintenance costs at the expense of adequate attention to factory buildings and their equipment. The tendency becomes more pronounced when depression demands unusual efforts to reduce costs. Eventually conditions become so serious that repair or replacement, costing far more than regular upkeep, is imperative.

In this article is outlined a program for systematic inspection and maintenance for factory buildings and their built-in equipment which, I have found, will give satisfactory results if persistently followed.

Organization in the maintenance department should be such as to provide a man or men, according to the size of the plant, to make weekly inspection trips covering every item in the buildings and their fixtures. In small plants the inspector may be able to handle minor repairs while making his rounds, but in large plants his only job should be inspection. Obviously, the inspector should be a maintenance engineer who has had the varied experience necessary to determine the true condition of the different items.

We use a weekly inspection sheet that lists all items to be inspected. As he makes his rounds the inspector checks off each item on the sheet as either O.K. or not, making notations concerning things to be done. When finished he submits the sheet to the head of the maintenance department with a report covering his recommendations. The sheet and report give the maintenance head a weekly picture of the condition of the buildings and fixtures and allow him to anticipate and schedule repairs. Succeeding reports, beside recording recently developed trouble, serve as a check against neglected repairs and the progress of work.

Discussion of some of the more important items of inspection and maintenance (the ones that in my experience have caused the most trouble) follows under their general headings.

Floors—Of the many types of building floors — concrete, mastic, wood, and wood block—concrete usually receives the most severe service and should be examined regularly. The inspector should check all floors for settling, excessive wear, level, and cleanliness. Mastic floor depreciates slowly, but in time the following disintegration is likely to take place: Cracking at the baseboards; baseboards pulling loose; pulling away from pipes and sleeves in the floor; and rotting of the underfloor, causing the mastic to settle. A good inspector will check the floor at these points.

Maintaining the level of floors eliminates accident hazards and expedites plant transportation and good workmanship. Satisfactory repair of concrete floors with a standard concrete mixture necessitates a large patch. Addition of an asphalt emulsion to the mixture results in a concrete that may be poured very thin. Cracked mastic floors may be repaired either by filling the cracks with new

Choosing suitable roofing materials and applying them skilfully insures long life and low maintenance costs for roofs.

mastic or heating the cracked portion with a blow torch so that the mastic flows together, closing the cracks. A smooth surface is obtained by the use of a trowel. The only practical method of repairing a worn wooden floor is to replace the worn section with new flooring.

Walls—Brick walls should be checked for disintegration at the joints of the brick courses, often caused by the action of frost. Concrete walls should be examined for cracking and breaking out. The latter is often caused by the action of rust when the reinforcing steel is too close to the surface. Joints, whether they are in brick, concrete, corrugated steel, wood, tile or composition walls, present an opportunity for water to seep through. In consequence, the inspector should check all wall joints for tightness, including all places where walls come in contact with the ground. Window frames should be investigated for shrinkage which, if excessive, leaves a gap admitting cold air to the building, thereby adding to the heating costs. All windows should be checked for cleanliness.

Open joints in brick walls may be repaired by cleaning them out and repointing with high-grade mortar. A good method of patching concrete walls that have broken out is, first, paint the exposed steel, and then fill the gap with cement stucco. Damaged tile walls may be patched with cement, brickwork, or preferably new tile. Rotted wood walls should be replaced with the same material to make a good-appearing job. A regular schedule of painting for wood, corrugated steel, and asbestos composition walls, as well as steel sash, windows and doors, should be maintained. I have found that repainting these items at least every three years gives them adequate protection.

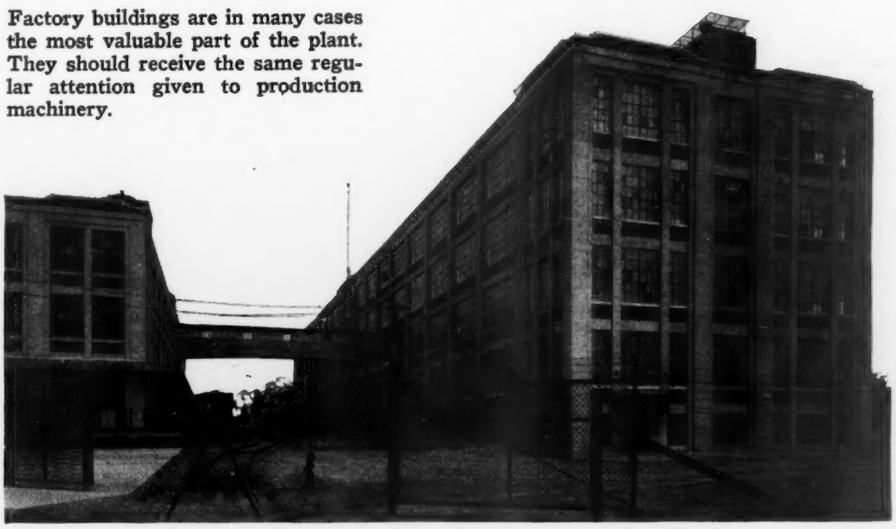
Painting can be scheduled in a large plant so that a certain number of buildings will be painted each year, thus distributing the work so that it will not be necessary to paint the entire plant in any one year. The presence of acid fumes often necessitates painting steel and iron more frequently than the recommended three-year period.

Windows should be washed at least twice a year in the average plant. Buildings with an excessive amount of dirt in the air, such as machine shops and foundries, often require more frequent washing of the windows. At our plant we have been able to use regular factory labor for this purpose.

Roofs—It is important in roof inspection to observe the condition of the roof decks, gutters, down spouts, and flashing. Failure to keep tight joints at the flashing has caused many leaky roofs. Saw-tooth and other sharply sloped roofs usually deteriorate faster than other types; they should be closely scrutinized in the inspection routine. The inspector should check the condition of all joints in gutters and downspouts because the action of frost and ice on the joints often loosens them and rust is more likely to be found at these points. Obviously such deterioration is more rapid in plants where acid fumes are prevalent. Other joints to be observed in roof inspection are to be found at valleys, hips, and flashing, where piping, pent houses, skylights, and saw-teeth are attached to the roof.

The maintenance department should understand the construction of every roof in the plant, whether tar and gravel, built-up, metal, or wood. Often the use of a more suitable compound will keep tar and gravel roofing on a steep slope. Leaky roofs of any type may be repaired by patching with plastic roofing cement if the leaks are small or, if large, with several plies of the same type of roofing. In repairing leaky tar and gravel roofs, the gravel must first be scraped off; then hot pitch and paper are applied and the gravel replaced. Metal gutters, down-spouts, and flashing, damaged at the joints, may be mended by resoldering.

Paper or felt flashing may be repaired with plastic cement or a new section of the original material. Built-up roofing may be painted when dry or cracked, considerably lengthening its life. Paint should be of a quality that will stay plastic and not crack under varying temperatures. I have found that a paint composed of asphalt containing asbestos fiber gives the best results. It should be applied with a brush when the roof is warm and the paint reasonably fluid.



Factory buildings are in many cases the most valuable part of the plant. They should receive the same regular attention given to production machinery.

Heating and Ventilating—Vacuum traps and valves on the radiators of the plant heating system should be given special attention in the weekly routine. The traps frequently require replacement of bellows and other operating parts. Radiator and supply valves to large heating coils should be examined carefully for leaks. Radiators seldom require attention, but occasionally a crack or a blowhole develops, causing a steam leak. Supports for wall-type radiators often work loose from the wall, especially where vibration is excessive. Pressures applied to radiators should be checked up occasionally to make certain that the allowable values are not exceeded. It is not customary to run over 5 lb. per sq. in. for cast-iron radiators.

The inspector should note the condition of the pipe insulation and see that all pipes are covered that should

be covered. Inadequate insulation brings expensive heat losses. In checking the alignment of pipes, the inspector should search for pockets interfering with the circulation of steam. The vacuum pump, heating coils, and reducing valves also require regular examination. Lack of injection water in vacuum pumps sometimes causes them to become steam bound, valves occasionally break, and packing wears. Leaks in heating coils are sometimes caused by piling material on them. Blowing out of diaphragms, weakening of springs, and scoring of disks are common causes of trouble in reducing valves.

Large pieces of equipment such as fans, engines, and pumps should be serviced daily by the operating engineer as part of his routine. I have made a practice of overhauling the entire heating system every summer when it is not in use. Such overhauling includes servicing and packing all valves; removal and cleaning of all traps; and the replacement of worn parts on reducing valves and the vacuum pump.

Fans, motors, and drives on the ventilating system should be inspected with special attention to the bearings. Duct work and dust collectors on ventilating and exhaust systems should be inspected for general condition, leaks, and clogging. Exhaust systems should be opened periodically to see that there is no accumulation of dust clogging the pipes; air suction also should be checked to make sure that it is up to the required value. Ducts passing outside of buildings should be painted and the joints soldered. Daily cleaning out of dust collectors facilitates efficient operation of exhaust systems.

Upkeep of the ventilating equipment should include the daily servicing of fans, motors, and belting by the maintenance department.

Lighting Equipment—Inspection of lighting switchboards should include all attached instruments such as meters, relays, fuses, and switches. Light reflectors should be examined for cleanliness, and lamps, switches, and fuses for condition and capacity.

The lighting switchboard should be cleaned, and all meters calibrated at least once a month. The correct level of illumination is maintained by keeping the reflectors clean and replacing lamps that are burned-out or of the wrong size. Reflectors in very dusty rooms should be cleaned about once a month. I have obtained satisfactory results in clean rooms by cleaning the reflectors once a year—in summer when lighting requirements are low. Any schedule for maintenance of lighting equipment should be controlled by the inspector's report.

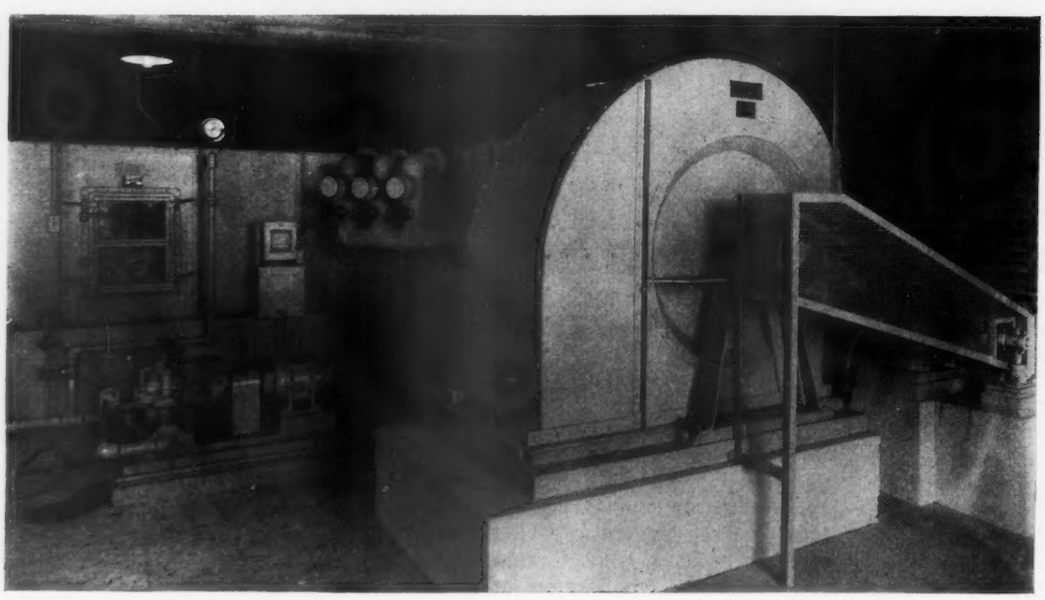
Sprinkler System—Daily examination of the important features of the sprinkler system—air pressure, water pressure, and condition of the fire pump—is justified by the importance of its purpose. All other items of the system should be inspected in the weekly routine. Of the two types of sprinklers, the dry-pipe system has more maintenance problems than the wet-pipe because the air supply in the dry line must be kept constant. In the dry type, dry valves should be examined for leakage and the air pressure checked. The inspector should satisfy himself that material is not piled high enough under the sprinkler heads to obstruct the proper distribution of water.

His check should include all features recommended for attention by the sprinkler manufacturers. Most insurance companies provide an itemized inspection blank, covering the entire sprinkler system. This blank may be used as a guide by the inspector. The routine should also include examination of all piping for leakage; checking the condition of all pumps and valves; noting the water level of the reservoir; and a sharp lookout for freezing in the water lines and reservoir in cold weather, especially when the heating system is shut down.

Sprinkler systems do not require regular servicing and should receive attention only when inspection shows the necessity. Leaks in dry valves are often caused by faulty diaphragms, which can be easily replaced. Installation of new disks in drain valves on the alarm equipment frequently stops leaks.

Fire Alarm Equipment and Supervisory System—The condition of this equipment should be determined in the inspection routine. The entire system should be tested at least once a

(Please turn to page 258)



Regular inspection and maintenance of ventilating fans and drives prevents breakdowns, safeguarding the health and comfort of the workers.

QUESTIONS *and* ANSWERS

Please submit answers promptly. We expect to publish no answers later than the second issue following the appearance of the question. Selection will be made on the basis of quality, but answers first received have the best chance of being used.

Should Building Temperature Be Allowed to Drop at Night?

Our plant consists of two main buildings, 300x200 ft., three stories high, with large window areas. About half of the original pipe coil radiation has been replaced with unit heaters. We have a low-pressure steam plant for heating only. Can readers tell me definitely: (1) From the standpoint of heating costs, is it advisable to maintain the daytime temperature constantly, or should it be allowed to drop during the night? (2) If it is advisable to let it drop, what is the minimum economical temperature? (3) What factors will determine the minimum economical temperature?

Boston, Mass. **A. I. M.**

■

What Will Be Corrective Capacity of This Machine?

We have a 125-kva., three-phase, 80 per cent power factor waterwheel generator and wish to float it on the line as a synchronous condenser during periods of low water. Will this generator, when operated as a condenser, have the same corrective capacity as an 80 per cent leading power factor synchronous motor of the same rating?

Northampton, Mass. **L. C. D.**

■

Phasing Out with Synchroscope

Some time ago I heard of a method of phasing out an a. c. generator that is to be operated in parallel with other alternators. As I recall it, this method consisted of making a series of tests with the synchroscope mounted on the board and connected to the generators through instrument transformers. Can anyone tell me just what the procedure is in using the method of phasing out referred to above?

West Allis, Wis. **R. C. D.**

Methods of Working Slate

I wish that readers would give me some suggestions on the best method of cutting and drilling slate switchboard panels up to 2 in. in thickness. It is necessary to make as neat a job as possible, and the work will have to be done mostly by hand, as no special equipment other than a drill press is available. When drilling slate what precautions are necessary to prevent the material from chipping away when the drill comes through?

Albert, W. Va. **F. P. H.**

SAWING the slate panels to the correct dimensions should always be the first step. Use a deep-back hacksaw frame for holding the blades. A flexible blade with medium teeth is best. After making the layout go over all the guide lines, scoring them deeply into the slate on both sides. With reasonable care in sawing a good, clean cut will be secured.

I find it best to hold the saw at a very close angle to the work, and saw from both sides, if convenient, as it permits one to remove the center part of the slate last. However, the procedure will have to be modified to suit the job. Support the end, even though it may be the waste end.

When drilling, keep the slab level, steady, and solidly backed by a pine board. This point is essential. Never start a hole with a drill larger than ¼ in. The drillpress speed should be about one-half that used for a piece of low-carbon steel. Use only a light pressure. Squirt water into the hole frequently.

With a ¼-in. drill it is safe to use the usual angle of point and lip clearance, but the larger drills used to bring the hole to the required diameter should be flat-ground. When setting up the panels for sawing or drilling, have enough men helping to avoid any possibility of the slab getting away. Also, the piece must be well supported. Do all work slowly and without much pressure. Keep saws and drills cool with water.

No trouble should be experienced in working slate if the above suggestions are followed. If something does go wrong and causes a trifling blemish, mix some of the slate dust with sodium silicate (water glass) and fill up the defect.

Denver, Colo. CARL A. WAGNER.

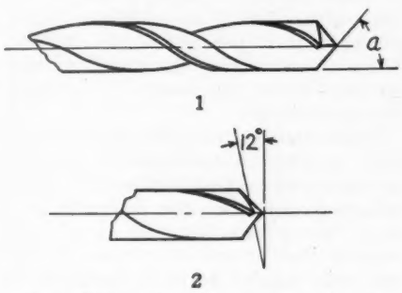
DIFFERENT varieties of slate are used for switchboard and controller panels, such as Monson slate, Vermont slate, and so on. Some slate contains veins of iron that make it unfitted for such purposes.

Slate panels cut to size can be purchased from the manufacturers, but in cases where it is necessary to meet definite requirements and special sizes, the slate is cut in specially-designed machines with special, carborundum wheels. A stream of water is directed at the cutting edge or surface of the high-speed wheel. In emergency, slate can be cut with a bandsaw, or by hand, using a heavy, fine-tooth hacksaw.

When the panel is finished to the proper size the holes are laid out, scribing a light center line and indicating the size of holes with a pair of dividers.

Special, high-speed drills with large flutes to prevent packing, as shown in Fig. 1, are used for drilling slate. The drill is ground so that angle *A* is approximately 65 deg.; hence it is less pointed than drills used for metal, which have angle *A* equal to 59 degrees.

In order to cut the hole the same size as the drill, both lips must be the same



For drilling slate, use a large-fluted drill, ground as shown here.

length and of the same angle. The back or clearance angle should be 12 deg. at the cutting edge, as shown in Fig. 2, and increase back of the cutting edge so that the line across the web is about 45 deg. with the cutting edge.

The slate to be drilled should be placed flat on another piece of slate on the drillpress table. The hole should be spotted with the circle and drill gradually fed through the slate under light pressure, easing off a little as the drill passes through.

Panels up to and including ¾-in. thickness can be drilled in one operation, without raising the drill to clear away the dust. With thicker pieces it is necessary to raise the drill to clear it about every ¾ in. of depth.

No lubricant is ordinarily necessary. Sometimes a hard spot in the slate will cause the drill to crowd to one side, making an odd-shaped hole. When a hard spot is encountered water should be used on the drill and the speed reduced.

A cutting speed of about 60 f.p.m. is used. This speed is based on the outer cutting edge. When using a ½-in. diameter drill the speed would be 456 revolutions per minute.

E. H. LAABS.

Engineering Department,
Cutler-Hammer, Inc.
Milwaukee, Wis.

■

Removing Rusty Fittings from Pipe

From time to time considerable quantities of iron pipe of all sizes up to about 3 in. accumulate in our scrap pile. We try to salvage as much as we can, particularly the brass and iron fittings and valves. However, it is often practically impossible to remove fittings that have become rusted on, although they are otherwise in good condition. I wish that readers would tell me the methods they have found most effective in loosening up rusty valves and fittings, so that they can be removed without too much distortion and effort.

Milwaukee, Wis. **P. J. D.**

I FIND that immersing rusty valves and fittings in a bath of Oakite solution and then washing them off with water cleans off all loose scale and dirt, and appears to penetrate rusty threads. Then by hammering them well around the thread they can usually be removed with a wrench.

When fittings are apparently immovable, soaking in kerosene oil until it penetrates all rust and scale will help to loosen them. Also, the application of heat, taking care to apply it in such manner that no undue stresses are set up, will usually make it possible to remove the most obstinate of fittings.

Arcadia, Calif. M. C. COCKSHOTT.

Winding Data for Transformer

Will someone please tell me the number of turns and size of wire to use in the primary and secondary of a transformer that will boost our line voltage from 75 volts to 110 volts? The supply is 60 cycle, and the transformer should be capable of handling an output of at least 400 watts. Any suggestions regarding the best shape and size of the core will likewise be appreciated.

Rockingham, N. C. **J. W. G.**

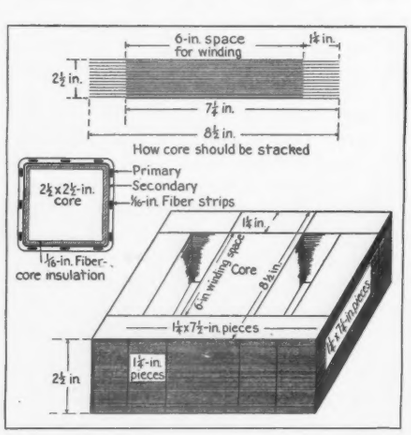
FOR a 1-kva., 60-cycle, 75/110-volt, air-cooled transformer, 50-deg. C. temperature rise, I recommend that J.W.G. use a core 2½x2½x8½ in. over all, leaving 1¼ in. on each end for the insertion of laminations for two magnetic paths of equal reluctance.

To make the core, cut 26-gage electrical sheet in the following dimensions and amounts:

1¼x7¼ in.....5 in. high
1¼x7½ in.....5 in. high
2½x7¼ in.....2½ in. high
1¼x1¼ in.....5 in. high.

Care should be taken in cutting the laminations to prevent burring, so as to reduce eddy currents and partial short-circuiting of the core.

Stack the 2½x7¼-in. pieces 2½ in. high for a 6-in. winding surface. Each piece should be varnished. After the core has been stacked hold it together with C clamps and bake. The remainder of the pieces are for the completion



Construction details of 1-kva., 60-cycle, 75/110-volt transformer.

of the magnetic circuit, and should be assembled as shown in the illustration.

Inasmuch as this transformer is designed for a low potential and output, any insulation of reasonable tensile strength, such as 1/16-in. fullerboard or ordinary fiber, should suffice for insulating the core.

The winding data are:

First layer—74 turns No. 13 s.c.e. wire

Second layer—50 turns No. 10 s.c.e wire

Third layer—74 turns No. 13 s.c.e. wire

Fourth layer—50 turns No. 10 s.c.e. wire.

The primary circuit comprises the second and fourth layers; the secondary is the first and third. I suggest using 1/16-in. fiber strips, say ¼x6 in., to separate the layers and promote air circulation. I do not recommend treating the winding with insulating varnish as it may retard the circulation of air. Furthermore, the voltage per turn equals approximately only 0.75 volt, and ordinary silk-covered-enameled wire will afford plenty of insulation between turns. EDWARD J. ALLEN.

Cleveland, Ohio.

■

How Much Can Belts Be Twisted Without Injury?

By placing several groups of machines at an angle to, instead of parallel with, the lineshaft that drives them, we can save space. Placing the machines at an angle will mean twisting the belts, which I suppose increases the wear and tear. Our belts are heavy single-ply, oak-tanned, 5 in. wide. Lineshaft pulleys are 30 in. in diameter: the machine pulleys are 12 in. in diameter. Lineshaft speed is 220 r.p.m. The drives are practically vertical. Center distance between line- and machine shafts is about 10 ft. Can readers tell me approximately the maximum angle between the line- and machine shafts at which these belts can be operated without seriously shortening their life or increasing maintenance costs?

Minneapolis, Minn. **J. Q. C.**

I SEE no reason why J.Q.C. cannot set his machines at any angle up to 90 deg. with his lineshaft, provided that the machines are clutch-operated, rather than driven through tight and loose pulleys. Some years ago I set up a battery of pigment mixers at an angle of 45 deg. and had no trouble with belts.

In the plant with which I am now associated I have recently set a machine at right angles to the lineshaft, in order to eliminate excessive handling of material in a battery of production machines.

J.Q.C. says his drives are practically vertical. They will have to be vertical if he wants to operate them at an angle with the lineshaft.

When purchasing new belts I would suggest that he specify "belt for a quarter-turn drive"; they will hug the pulleys better. CLARENCE A. GIBBS.

Herkimer, N. Y.

BOOKS

■ ■ ■

Autobiography of an Engineer

By William LeRoy Emmet, General Electric Company. Published by the Fort Orange Press, Albany, N. Y. Cloth, 213 pages. Price $2.

THE author recounts, with a charming naivete that adds much to their inherent interest, the details of some personal failings and qualities, as well as many experiences in his long career as an engineer and inventor. A graduate of the United States Naval Academy, he saw active service in the Spanish-American War. In civil life, his work on the development of the steam turbine, electric propulsion of ships, and other important projects brought him into contact with many well-known engineers, inventors, and business men, including Thomas A. Edison, Samuel Insull, and E. W. Rice, former president of the General Electric Company. His relations with these men are interestingly told.

Best known for his invention of the mercury turbine, Dr. Emmet is one of the famous quartette—Elihu Thomson, Charles P. Steinmetz, and Willis R. Whitney—whose names and work are inextricably associated with the General Electric Company.

To the young engineer of today this book will give an intriguing glimpse of the ceaseless toil that has attended the development of some devices and equipment that are now commonplace.

■

Treatise on Leather Belting

By George B. Haven, Prof. of Advanced Machine Design, and George W. Swett, Prof. of Machine Design, both of Massachusetts Institute of Technology, Cambridge, Mass. Published by the American Leather Belting Association, New York, N. Y. Cloth, 77 illustrations, thumb-indexed, 250 pages. Price $1.50.

LEATHER belting has long occupied a prominent position in mechanical power transmission—and justly, because of its special properties for many classes of service.

Collected in this volume is ample information on the subject for the requirements of the maintenance engineering forces, purchasing agent, and engineering student. Leather is traced through all preparation and manufacturing process from the raw hide to the finished belt; classes, grades, and physical properties are described.

Practical data on applications, installations, and maintenance include the relation of the belting in the complete drive to pulleys, shafting, bearings, hangers, and motors; special attention is given to angular drives and short—center drives.

Scientific treatment of the problems of power transmission through belting is given in chapters on belt-drive engineering and belt research; such subjects as creep, tension, and angle of wrap are fully covered.

Intelligent purchase of leather belting is expedited by the inclusion of sample specifications and a description of inspection methods. Mathematical tables, charts, and graphs complete the contents.

■

Materials Handbook

By George S. Brady, Managing Editor, "Product Engineering." Published by the McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y. Second edition, flexible binding, 588 pages. Price $5.

IN THE past few years the number of raw materials used in engineering and manufacturing has increased rapidly. This book provides quick reference data on materials, new and old, sufficient to satisfy the requirements of the purchasing agent, engineer, and executive of the average plant. In this edition the engineer has been given an increased number of comparative data on physical properties.

Materials are classified alphabetically and indexed. The appendix contains conversion tables and classifications for marketing iron and steel scrap.

■

Modern Diesel Engine Practice

By Orville Adams, Consulting Engineer. Published by The Norman W. Henley Publishing Company, 2 West 45th St., New York, N. Y. Cloth, 656 pages, 400 illustrations. Price $6.

ENTRANCE of the Diesel engine into new fields, such as the bus, locomotive, and more recently the airplane, has brought with it a growing public interest in its development.

Publication of a comprehensive reference on all phases of this prime mover is the purpose of this book. Not only are the theory and applications covered, for the benefit of the student and designing engineer, but operation, maintenance, and repair are fully presented in a manner sufficiently practicable to be useful to the operating and maintenance forces.

■

Concrete Handbook

USEFUL and up-to-date information on concrete, both plain and reinforced, is contained in the Handbook of Concrete Construction issued by the Universal Atlas Cement Company. The book is written from a practical rather than a technical standpoint. It makes no attempt to cover the field of large construction projects requiring skilled technical handling. It is a pocket manual of general information on concrete, applying particularly to smaller structures.

The book has 208 pages, is well illustrated, and contains 48 tables on quantities, sizes, loads, and so on. It also has an index.

Copies may be obtained by addressing the Handbook Department, Universal Atlas Cement Company, 208 South LaSalle Street, Chicago, Illinois.

■

Physics

By Oscar M. Stewart, professor of physics, University of Missouri. Published by Ginn and Company, 15 Ashburton Place, Boston, Mass. Second edition. Cloth, 770 pages, illustrated. Price $4.

THE present volume is the thoroughly revised edition of an elementary college textbook of physics, which has been prepared with particular reference to the capabilities of students who have not had special mathematical training. Both the subject matter and the illustrations have been chosen to give a large amount of useful information. Fundamental principles are illustrated by many examples drawn from common experiences. Recent developments in so-called "modern" physics have been conservatively and skilfully handled to give the greatest amount of knowledge and the broadest viewpoint without confusion. Many new applications of physics are given full treatment. These include new refrigeration processes, the photo-electric cell, recent developments in radio and sound reproduction, and so on.

Those who wish to review earlier training in this important subject, as well as those who desire to approach a systematic study of it for the first time, will find this volume helpful.

(Please turn to page 258)

Fifth article of a series. The sixth will appear in an early issue.

LUBRICATING SYSTEMS

(High-Pressure)

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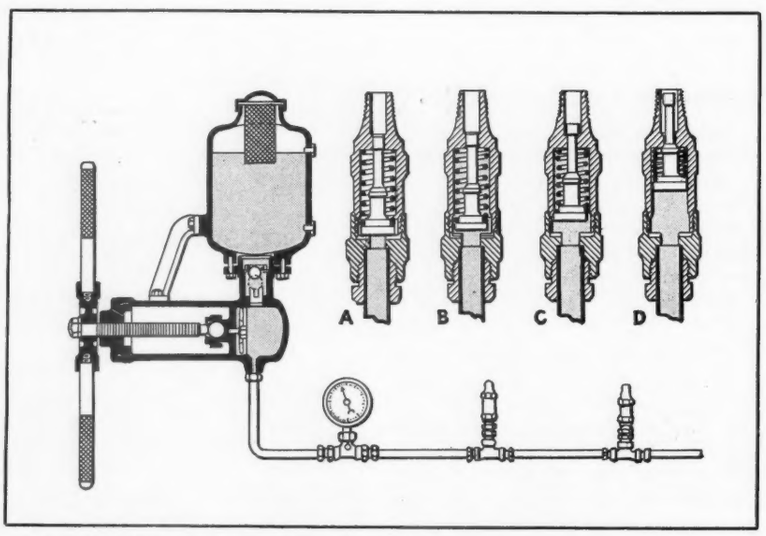
A SYSTEM that will handle measured quantities of oil or grease to bearings, under pressures of 1,000 lb. per sq. in. or more, where necessary, is shown in Fig. 34. The lubricant flows from a reservoir through a check valve to a compressor which may be either hand or automatically controlled.

When the compressor is actuated by the handwheel, the lubricant is forced under considerable pressure into the system and finally into the bearing through an automatic valve or metering outlet valve, the action of which is shown by means of the sketches in Fig. 34. When there is no pressure on the system the valve takes the position as shown in *A*. As the pressure builds up, the piston moves forward as indicated in *B*, the lubricant passing around the piston, completely filling the valve chamber. When the forward movement brings the valve into the position indicated in *C*, the large head interrupts the flow of lubricant into the fitting. At this point the outlet to the bearing is just about to open. As the forward motion continues, a measured quantity of lubricant is discharged into the bearing, finally sealing the outlet when the valve reaches the position *D*. A constant pressure on the gage indicates that each metering valve has functioned in delivering its charge to its respective bearing. Withdrawing the plunger in the compressor relieves the pressure, permitting the springs in the outlet fittings to return the valves to their original positions.

The quantity of lubricant supplied to any bearing is determined by the size of the valve installed at that point. This manufacturer uses a swivel and a flexible hose connection, as shown in Fig. 35, in feed lines affected by mechanical motion.

With the centralized system just described, the single main pipe line supplying lubricant to the automatic metering valves does not require separate lines from the valves to the compressor. The system is applied for the distribution of any type of oil or grease, the density of which does not exceed that of a soft semi-fluid grease.

According to the manufacturer, it has been found from experience in its application to a large number of bearings that proper lubrication to some bearings requires lubricants of much heavier consistency. For this



Figs. 34 to 37 inclusive courtesy Lubrication Devices, Inc.

Fig. 34—Oil reservoir, pump, and piping scheme of a single-line, centralized lubrication system. Sketches at A, B, C, and D show successive positions of metering outlet valve during the functioning period.

heavy-duty service a system, designated "Dualine," that will distribute any type of lubricant that can be pumped through a line has been developed. It is intended specifically for the lubrication of equipment commonly used in steel, cement, paper, sugar, and rubber mills.

Like the single-line system it includes a positive, piston-displacement-type metering valve for each bearing or point of application. The operation of the valve is fully automatic and is controlled entirely by hydraulic pressure, furnished by the pumps from one central station. This system differs from the single-line in that two supply lines are connected to each valve. One line loads each valve with a measured quantity of lubricant at high pressure; the other line discharges this measured quantity into the bearing at high pressure. The system is available in the hand-operated unit, or in the automatic type where the frequency of operation is controlled by an electric time clock which can be set at any interval of from two minutes to two hours.

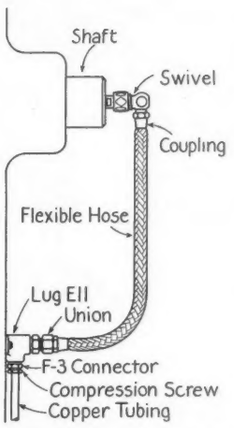


Fig. 35—To relieve strain on the system, a swivel and a flexible hose connection can be used to advantage.

Briefly, it consists of one central compressor, two main supply lines, and the metering valves, as shown in Fig. 36. In the central pumping station a double-compartment reservoir serves two individual plunger-type guns. One gun delivers the heavy grease to charge all the valves; the other provides the necessary oil pressure to discharge the valves. Transfer of lubricant from barrel to reservoir is direct, without exposure to air or foreign matter.

To operate the system, a pressure of 1,000 lb. per sq. in. is first developed in the grease chamber. The fact that this pressure has been obtained is a direct indication that all valves have been filled with a measured quantity of lubricant. Then the oil pump is operated until its gage registers the same pressure, which indicates that all valves have discharged their measured quantity of lubricant into the bearings at 1,000 lb. per sq. in. pressure.

By means of the drawings, Fig. 37, the operation of the system will be

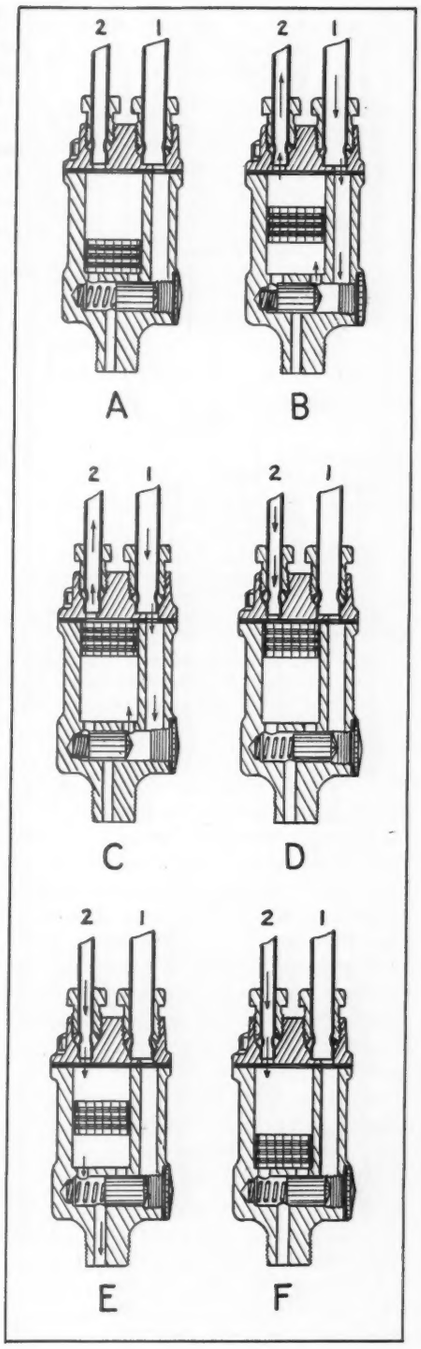


Fig. 37—Outlining the scheme of operation of the automatic metering valves employed in lubricating heavy-duty equipment.

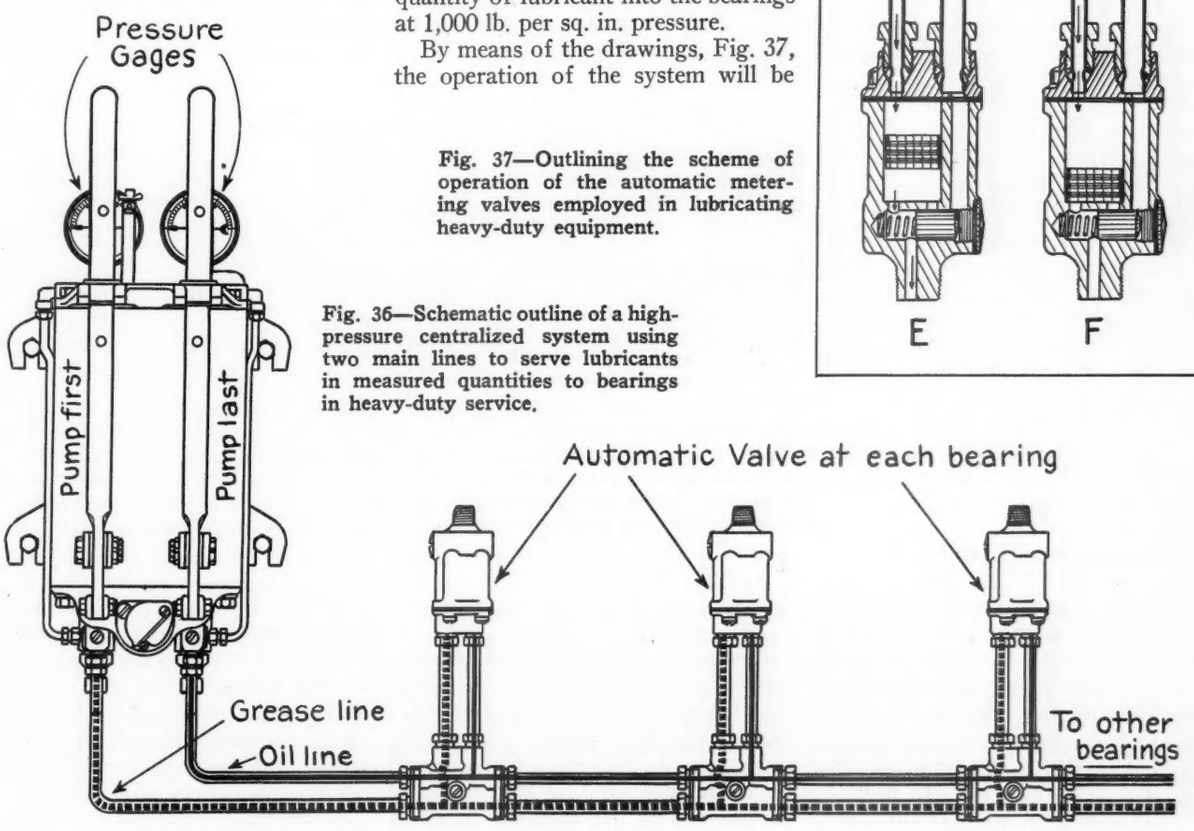
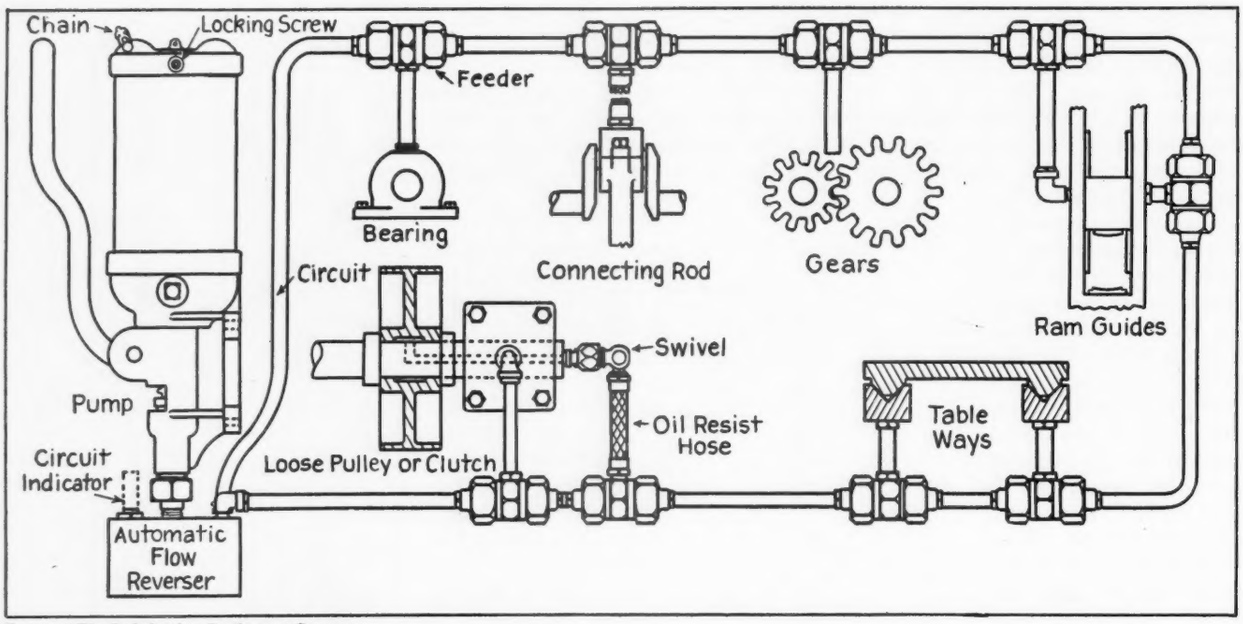


Fig. 36—Schematic outline of a high-pressure centralized system using two main lines to serve lubricants in measured quantities to bearings in heavy-duty service.



Courtesy The Lubricating Equipment Company.

Fig. 38—A progressive system of centralized lubrication in which the flow of lubricant in the main line is reversed after the last feeder has been discharged. Each feeder must deliver its charge of lubricant to its bearing before the next feeder in line receives any of the lubricant.

more easily understood. In *A* the valve is in the normal position with no pressure on either line. No. 1 indicates the grease line, No. 2 the oil line. In *B* pressure has been applied to the loading line, and in *C* the valve chamber has been completely filled with grease. With both ports to the primary chamber uncovered, a pressure of 1,000 lb. per sq. in. is obtained at each end of the small piston valve when the valve chamber is filled. The small piston valve in *D* has been transferred by the action of its spring, closing the grease inlet port and opening the discharge port. In *E* pressure has been applied to the oil line, which acts on the primary piston, forcing the lubricant into the bearing. With the last valve in the line fully discharged as in *F*, by pressure from the oil or shooting line, the system is ready to be operated again as described.

A progressive system for lubrication that can be operated with a hand- or power-driven pump is schematically outlined in Fig. 38. It embodies a complete circuit in a single main supply line starting at the source of the lubricant, touching each point of application, and returning to the source. The feeders in this system are made in various sizes so as to get different quantities of lubricant to the various sizes of bearings to be served.

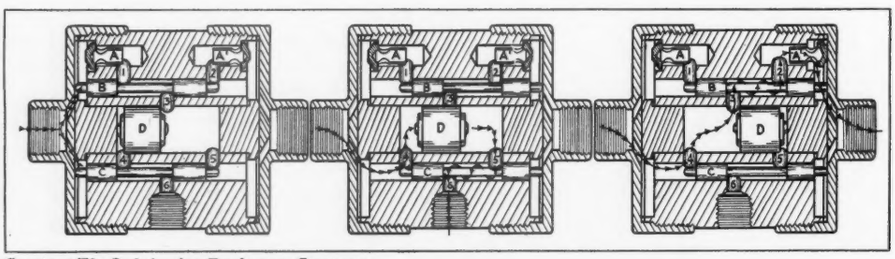
As with other types, the line is always filled with lubricant which is under pressure only when lubricating. Just as the fresh lubricant is started through the line, the first feeder delivers its quantity of lubricant to its bearing, after which the main supply proceeds to the second feeder and so on until the circuit to the pump is completed.

One of the features of this system is that the lubricant cannot pass the first feeder or any other feeder in the line unless that feeder delivers its charge to its bearing. Each feeder must function or else the lubricant cannot pass on. An indicator installed at the pump gives positive indication to the attendant that a complete circuit has been made.

Should the operator continue to pump without reversing the circuit, the lubricant will simply pass through the line to the pump. The indicator will register, but no lubricant will be delivered to the bearings. To lubricate each time, the circuit must be reversed, which action may be accomplished automatically or by hand.

Pressure sufficient to overcome bearing resistance will be developed by the pump, that is, if 100-lb. pressure, or 5,000-lb. pressure, is required, the pump will develop it to actuate the feeders.

Sectional drawings, Fig. 39, are



Courtesy The Lubricating Equipment Company.

Fig. 39—Operation of the feeders when lubricating a bearing. At the left the feeder is shown in the neutral position with the chamber filled with lubricant from the last operation. The center view shows the feeder with both dumb-bell pistons moved to right and the piston in position to discharge the lubricant to the bearing. In the view at the right the lubricant is filling the chamber for the next application and passing on to the next feeder in the main line.

used to show the operation of the feeders in this system. The feeder has a main floating piston and chamber the size of which determines the amount of lubricant that is to be discharged.

Then there are two floating dumb-bell pistons operating in their respective chambers. The lubricant passes from chambers to bearings by means of proper ports. A resistance plug *A* at each end of the dumb-bell piston *B* insures the operation of the dumb-bell pistons.

As the lubricant enters at the left, first view, Fig. 39, it pushes dumb-bell pistons *B* and *C* to the right, uncovering port *4* to allow the lubricant to flow into the main chamber. The arrows in the drawing on the preceding page indicate the path of travel.

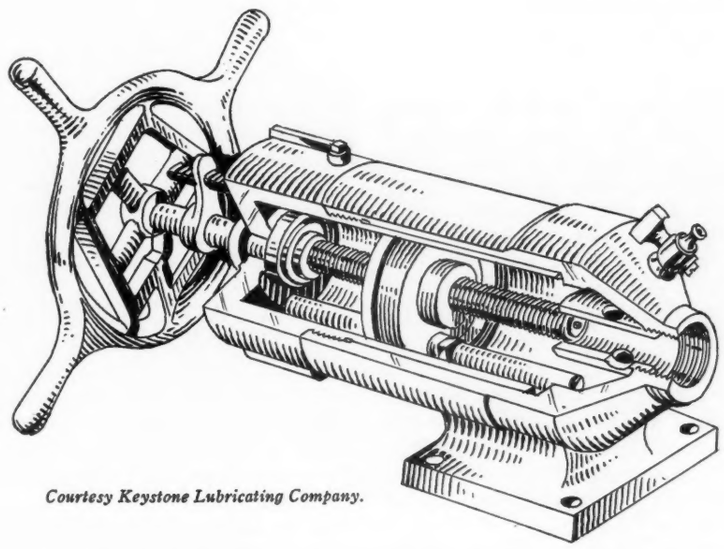
The main piston *D* is moved to the right, which forces the lubricant lying to the right of piston *D* through ports *5* and *6* into the bearing.

When piston *D* has moved to the extreme right, as in the view at the right, port *3* is open and the lubricant from the main line, coming through port *4*, passes through port *3* and out port *2* into the main line again toward the next feeder.

For the next application of lubricant the operation of the feeder is reversed.

That the saving in labor effected by these central systems is worth while may be gleaned from the fact that in one plant 5,000 bearings are cared for by 240 of these systems while as many as twenty small machines are lubricated at one application of a single compressor. In some instances, central systems operated by one man produce the results formerly obtained by ten men working with older methods of lubrication.

Another central, hand-pressure system uses a gun or a compressor of the type shown in Fig. 40. The gun, or lubricator, as it is termed by the manufacturer, may be filled by unscrewing the cylinder and applying the grease with a paddle or it may be forced into the cylinder through a petcock from a pressure-producing container. A typical example of a lubricator of this type is shown immediately above.



Courtesy Keystone Lubricating Company.

Fig. 40—Sectional view of a screw-type compressor for a hand feed, centralized, grease-handling system.

Screwing in the piston of the compressor forces the grease into the pipe lines through a conical strainer. At each point to be lubricated there is a reduction valve of either the needle or cock type, the proper adjustment of which proportions the amount of lubricant to be delivered to each bearing.

Indication that lubrication is being supplied is noted by the excretion at the ends of the bearing or by using the tell-tale in the regulating fitting to observe the flow in the line.

Where some bearings require more lubrication than others so that the regulators will not take care of the difference, separate branch lines with quick-acting valves may be installed. Thus grease may be forced into any desired branch line as often as required.

Two New Standards Approved

AMERICAN Tentative Standards, Specifications for Refined Wrought-Iron Bars (G12-1931), and Specifications for Wrought-Iron Plates (G13-1931), have been approved by the American Standards Association.

These were submitted by the American Society for Testing Materials as sponsor.

Both specifications were originally approved by the ASA in 1923 as American Tentative Standards. They have now been revised by the addition of a definition for wrought iron and the elimination of the reference to puddling.

The elimination of the reference to puddling affects the specifications concerning the manufacture of the products. The original specifications stipulated that the bars, according to G12, and the piles, according to G13, should be made from puddled iron. The revised specifications simply specify that the bars and piles shall be made from wrought iron.

Copies are available from the American Standards Association.

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Waste Elimination Suggestions May Contain 500 Words

LAST month we announced the offer of a $50 award to the person submitting the best suggestion on any phase of waste elimination in industry, and a certificate of award to the company employing the winner. Since the publication of that statement the number of words permitted in the letter containing the suggestion has been increased from 300 to 500.

The award is made by the National Industrial Equipment Exposition and the letters should be sent to that organization, at 308 W. Washington St., Chicago, Ill., prior to midnight of May 30, 1931. The letter should show how the idea can be carried out and should state the estimated savings. It may be accompanied by a sketch if necessary.

As before, the award will be made on the basis of: (a) the quality of the suggestions, and (b) the greatest practical use of the suggestion to American industry in general.

Loading Low-Voltage Underground Cable

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ONE of the first things a chief electrician or plant engineer wants, when he becomes responsible for the operation of an underground cable system, is data on the loads that may safely be carried.

He is familiar with the Underwriters' table of carrying capacities of rubber-covered wires in conduit, and searches for a similar table on lead-covered underground cables. Perhaps he finds several such tables, each applicable to certain specific conditions, but entirely lacking in agreement. Eventually he realizes that no such general table is possible. The permissible loading of underground cables depends upon many things besides the size of conductors.

The subject is too broad to be covered in an article of reasonable length. All that I shall attempt to do here is show why a single all-inclusive table is impossible, and then consider a tabulation that an engineer may work up to cover his own conditions with some quantitative data that will be useful in estimating allowable loads.

We ordinarily consider that the condition determining allowable loading is the temperature of the cable insulation at the hottest spot, the surface of the copper conductor. Safe values have been specified by the American Institute of Electrical Engineers in their Standardization rules. For general use they are as good as any and better than most others: manufacturers' guarantees are ordinarily based on these A. I. E. E. standard temperatures. This article is concerned principally with paper-insulated, three-conductor cables built for 2,300 volts or less.

For such cables the A. I. E. E. rules specify a maximum temperature of 85 deg. C. or 185 deg. F. It might seem that a very simple tabulation would give the allowable currents for this temperature. So it would, if the air surrounding the cable were always at the same temperature. With any given current the difference in temperature between the copper and the air outside of the sheath is reasonably fixed. Any difference in heat transmission between conductor and sheath due to the construction or age of the cable will be small compared with the differences beyond, and may be neglected for our purpose.

The heat must get from the air surrounding the cable in the duct into the earth outside, and thence away. Here are the big variables. There is the difference between winter and summer temperatures in the ground, and between one cable in a single duct, and a number of cables in a duct bank. In the latter case the heat from the cables near the center of the bank must travel, perhaps through several layers of ducts containing heavily-loaded cables, before it reaches the earth. The effect of this depends largely upon the size and loading of the other cables in the same run of duct. Less obvious is the effect of drying out of the earth outside of the bank.

The temperature of the earth outside a heavily-loaded duct bank is far higher than the temperature 20 ft. away. The difference depends upon the sort of earth and the amount of moisture it contains. Within the same plant the earth may vary from well-drained cinder fill to wet earth, or from a trench blasted in rock and backfilled with spalls, to a quagmire. A big bank of heavily-loaded cables will heat up the ground considerably, particularly if the load is almost continuous, and possibly dry it out for a short distance around the duct. Dry earth surrounding a duct is almost as good a heat insulator as pipe covering.

On the other hand, in a plant where the buildings are one-story and there are no sewers in the mill yard, the whole duct line may be submerged at all times. These variations in ground conditions, size of duct banks, and size and loading of remaining cables in the bank profoundly affect the allowable loading of the cable in question. It is obvious that no single table of loads for three-conductor, low-voltage cables of different sizes can even approximately indicate the loads for the maximum allowable heating.

About 20 years ago Saul Dushman* and others published formulas and tables for determining the difference in temperature between the copper and the air surrounding the sheath, for various types of cables and for any ampere load. Testing showed that Dushman's formulas agreed almost perfectly with some cables that were keeping me awake nights. To determine the temperature of the surrounding air in the duct, we tried pulling a thermometer into it, halfway between manholes, with a piece of twine. At about the time of heaviest load we would pull the thermometer out as rapidly as possible and read it. The reading dropped rapidly while we were taking it, and we could not tell how much it dropped while the thermo-

*Transactions A.I.E.E., 1913, page 333.

meter was being pulled out from the duct; so we lacked confidence in our results.

Then we put the thermometer bulb through a cork into a bottle full of oil, which we placed in a cigar-shaped basket made of band iron, and dragged the whole back and forth through the duct. The oil held the temperature fairly well. This procedure seems crude now, but it gave us something definite to work on. We were able to increase our cable loads enough to save the entire cost of the cables every two or three years and still not lie awake nights.

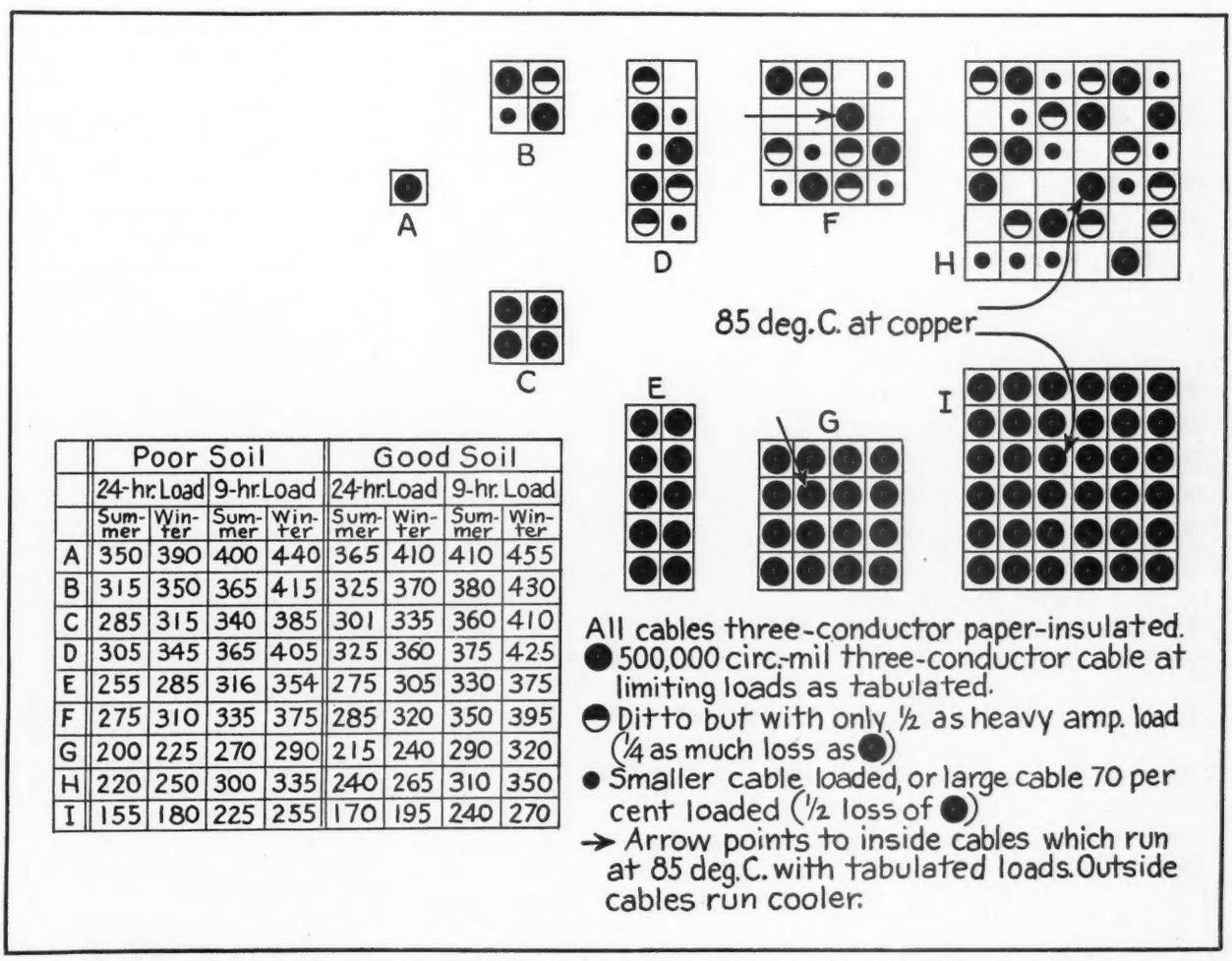
Later on, portable pyrometers were developed for low temperatures. We obtained a couple 100 ft. long and pulled it back into duct lines where we feared excessive temperatures, but we never obtained the kick from using it that we had from the thermometer and bottle. We didn't invent pyrometers! During the past few years several men* have published far more accurate and complete data than we collected by our crude experiments. There are now available at least two methods for determining allowable loads on almost any sort of cable in any duct line and with any sort of ground conditions.

We must except hot spots due to buried steam pipes and other external sources of heat. These methods are general, but they are far from the simple tabulations which we would like. Every case is a problem that requires an hour or so for solution. It is evident from the above that no one can reduce this matter to a simple table like the Underwriters' table of carrying capacity for rubber-covered wire. However, with the rapid progress that is being made in reducing the available data to usable form we may expect something within a few years that will be rapid, and suited for use by men who are not specialists.

I believe that the most promising method of attack is a family of graphs embodying the available knowledge of duct heating constants for use with Atkinson's chart, published as a Lefax sheet. This chart in its present form is useless for the practical man because the determination of the duct heating constant becomes a wild guess, but with the data available today a general graphical chart for duct heating constants could be developed.

Meanwhile, what can be done for the man who has to solve such problems more or less frequently, and quickly? Generally his problems do not cover a broad field. All his underground cables are three-conductor; all have the same sort of insulation, paper or varnished cloth. Almost all his cable operates at one voltage, generally 2,300 volts or below. Years ago each cable he

*Kirke, Journal A.I.E.E., October, 1930. Levy, General Electric Review, 1930, page 230.


A
B
C
D
E
F
G
H
I
85 deg.C. at copper
All cables three-conductor paper-insulated.
● 500,000 circ.-mil three-conductor cable at limiting loads as tabulated.
◓ Ditto but with only ½ as heavy amp. load (¼ as much loss as ●)
● Smaller cable loaded, or large cable 70 per cent loaded (½ loss of ●)
→ Arrow points to inside cables which run at 85 deg.C. with tabulated loads. Outside cables run cooler.

	Poor Soil				Good Soil			
	24-hr. Load		9-hr. Load		24-hr. Load		9-hr. Load	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
A	350	390	400	440	365	410	410	455
B	315	350	365	415	325	370	380	430
C	285	315	340	385	301	335	360	410
D	305	345	365	405	325	360	375	425
E	255	285	316	354	275	305	330	375
F	275	310	335	375	285	320	350	395
G	200	225	270	290	215	240	290	320
H	220	250	300	335	240	265	310	350
I	155	180	225	255	170	195	240	270

Tabulation that forms the basis for determining permissible loads on underground distribution cables operating at 110 to 2,300 volts.

bought was of a size to suit the load served, but the loads outgrew these cables. Soon the ducts were filled with small cables no longer suited to the loads. Of late years he has standardized upon the largest cable size that can be pulled into the ducts. For heavy loads, cables are multipled. Two or more light loads, or departments, are carried on one cable. Where conditions are as outlined above, enough variables have been eliminated to enable one to solve ordinary problems rapidly. There will still be some extraordinary problems that require figuring step by step.

Consider the following tabulation, which will meet the needs of many plant men: Assume that all cables are three-conductor, paper-insulated, lead-covered, 500,000-circ. mil, operating at any voltage from 110 to 2,300 volts inclusive. Cable of 500,000-circ. mil area is about the largest size of round-conductor cable that can be pulled into nominal 3-in. tile ducts, (actual 3⅜ in.) unless runs are short or very straight indeed. Then the chart gives the basic data for the solution of most distribution problems.

A direct answer to every problem may not be found in the chart, but remember that Figs. *B, D, F,* and *H* represent rather lightly loaded duct banks, whereas Figs. *A, C, E, G* and *I,* represent more heavily loaded banks than will ever be met. Between the figures for these two arbitrary conditions one can interpolate for any intermediate loading. Considering everything, the accuracy of such interpolations should be well within the accuracy of assumptions as to loads.

One must play safe as to ground conditions in planning for the future, as during an occasional dry summer like the past one, many a "wet hole" and moist run of duct dries up to an astonishing extent. One must consider also the possibility of the drainage of moist areas by new sewers that may be run in the future. The tabulations in the chart as given under Winter and Summer are based on temperatures in Chicago, Ill., and should be close enough for the northern part of the United States. No doubt they are conservative for winter in New England and the Northwest. Temperatures underground change slowly; a few exceptionally cold weeks, or warm ones, make very little difference. Bury a thermocouple or two and read it every week for a couple of years, as we did, and convince yourself. These data cannot, of course, be used directly in the South.

For a plant having a standard size of distribution cable decidedly smaller than 500,000 circ. mil, it will be necessary for the engineer to work up his own tabulation. This is a laborious procedure, but such a tabulation will be a great time saver.

Considerations in Applying the Chart

Temperature—The tabulated ampere capacities are based on the A.I.E.E. standard temperature at the conductor (copper) surface of 85 deg. C. for paper insulation at voltages of 110 to 2,300 volts.

Soil Conditions—Poor Soil in the tabulation refers to (1) duct lines in fairly well drained sand—sewers in the same street at a lower level. (2) Duct lines in a trench blasted from rock and backfilled largely with rock waste and some earth. (3) Duct lines in earth from which the moisture has been baked out for a few inches around the duct. In soil that is well drained, runs like Figs. *E* and *F* will bake out a layer around the duct bank. A run like Fig. *C* will do so on 24-hr.-per-day service. Unless water stands in undrained holes, up to the duct line, a bank like Fig. *I* and probably *G* also, can safely be assumed to have dried out a crust—surely on 24-hr. service approaching capacity load.

Very Bad Soil—Soil conditions that are worse than Poor Soil are occasionally met. Then cable loading must be reduced below that tabulated for Poor Soil conditions. Only in extreme conditions is it necessary to reduce loads as much below the tabulated amperes for Poor Soil, as Poor Soil amperes lie below Good Soil amperes.

The following may be classed as worse than Poor Soil:

1. Well-drained sand. This will dry out for some distance around a heavily-loaded duct line.

2. A line in a trench blasted in rock and backfilled with spalls, without much attempt to fill the voids with earth.

3. A duct laid through a "brickbat" fill.

4. Pure slag fill and pure cinder fill.

Good Soil—Ground containing enough water so that it will not become bone dry for a few inches around the duct bank.

Exceptionally Good Soil—In locations where there are no sewers, heavier loading may be allowed than tabulated under Good Soil. Such conditions are entirely the result of ample moisture in the soil. In any case where water seeps at all times from the ends of the lower ducts of the bank into the manhole, conditions are better than assumed under Good Soil. In lines where the ducts are always full of water, the conditions are far better than Good Soil.

It is difficult to specify how much heavier loading than tabulated under Good Soil is allowable in such cases. For 500,000-circ. mil, three-conductor, paper-insulated, submarine cables submerged in water with no earth covering them, the ampere loading may be increased about 60 per cent above the loads tabulated for "A" Good Soil, 9 hr. per day. It makes no difference how long such cables are loaded. They will carry the same load continuously that they will carry for two hours. Unfortunately, it is seldom possible to take much advantage of this fact. Even if larger cables are pulled in on shore to connect to a submarine cable, the shore-end manholes are seldom deep enough to keep the shore ends of the river section submerged. If the cable is laid in a dredged trench that is back-filled, or gradually backfills itself, the cooling of the river section is reduced, as the water in the earth around the cable cannot circulate.

About all one can say is that for duct lines that always drip water into the manholes, it is safe to load them as much above the tabulated Good Soil amperes as these values exceed the Poor Soil amperes for the same conditions. When the manholes fill up above the level of the ducts, so that the cables are submerged throughout the run, still higher loadings are permissible.

This matter is of interest in determining the permissible ampere load through the peak period of a particular year, but one would seldom dare to select cable for a number of years' service on such a basis, for fear that drainage might be installed in the future along some parts of the run.

Hours of Service—The data are tabulated for 9 and 24 hours of full-load operation out of each 24 hours.

In most 9-hr. plants, the load is not uniformly heavy all day. If the average load for the heaviest hour is taken as the full load, it is possible, on the 9-hr. tabulation, to operate a few cables in each bank at half load during the night shift. Duct heating is proportional to the current squared, and the decreased heating at the beginning and end of the morning and afternoon periods will offset the heating from a few lightly-loaded cables at night.

The difference in ampere capacity between 9-hr. and 24-hr. service is due to the heating of the ground surrounding the bank and the duct material itself, and not to any storage of heat in the cable. The 24-hr. data approximate the conditions in a three-shift plant, although a few plants operate without any decrease in load at shift-changing time.

Seasonal Change—It takes some time for the soil under ground to heat up when spring comes, and some time to cool off in the fall. Summer data in the table are correct for July, August, and September, and Winter data for January, February, and March, in Chicago. Spring and fall months permit intermediate loadings, with November and May about half-way between Winter and Summer ampere loads.

Cable Styles and Types—The chart was calculated for three-conductor, cables, round conductors, 3/32 x 3/32-in. paper, ⅛-in. lead. Other insulation thicknesses from "low voltage" (about one-half of the above insulation) to 5/32 x 5/32-in. paper makes very little difference within the 110- to 2,300-volt range, Greater heating from the increased insulation thickness is about half offset by the increased radiation due to increased outside diameter. The total variation from this cause within the limits specified amounts to less than 2 per cent of the amperes tabulated. With more than four holes in the duct it is less, and very much less in large ducts.

Use of sector cable instead of round-conductor cable makes very little difference, within the voltage and insulation limits specified. In fact, sector cable with thin insulation generally runs cooler than round-conductor cable. The smaller lead surface is more than offset by the better heat path inside. The difference lies between 1 and 2 per cent, and is less for thicker insulation.

Duct Bank Sizes—No sane engineer would nowadays install a 6 x 6 duct bank like Fig. *I*, full of heavily-loaded cables. Many such jobs have been installed in the past, however, and many 6 x 6 banks are in service today. The data given are useful to interpolate from, in estimating the performance of intermediate sizes of banks.

Locations of Limiting Temperatures—In all banks more than two ducts wide, even when filled with cables of the same size and equally loaded, there is a belt of ducts around the outside in contact with the ground, which run coolest; a belt inside these whose heat must pass through the outer belt to reach the earth; and in the case of a 6 x 6 duct bank, a third inner belt or row, whose heat must pass through both outer rings to reach the earth. In every case in this tabulation, both for fully-loaded and for partly-loaded banks, the limiting ampere loads given are based on equal loads for similar cables in all layers, and limiting (85 deg. C) copper temperature for heavily-loaded cables in the innermost row of ducts.

It might be thought possible, by varying the load on the cables in the inner and outer rows, to run them all at 85 deg. C. Actually this is not practicable. It is possible if no cables in different rows are multipled, but it would require running the cables in the inner rows with impracticably-light loads. The surface of each inner cable must be, practically speaking, hotter than the outer ones to cause heat to flow out through the duct occupied by the outer cables.

The only drop available for juggling is the drop through the cable insulation itself, plus part of the surface-to-the-air drop. It is worth while to take advantage of this difference in belt temperatures. Put high-tension cables at the outside of the bank, and toward the bottom if convenient. Put cables that will be lightly loaded, in inside ducts. There is some variation in temperature in each belt of ducts, the upper ducts being somewhat hotter. This variation is smaller than from belt to belt, and may be greatly varied or reversed by the arrangement of cables in the bank. It has been neglected in preparing the table.

Other Insulation—When all the cables in a bank are varnished-cloth insulated they can be loaded to about 92 per cent of the tabular values in summer, and 94 per cent in winter. When most of the cables in the bank are heavily-loaded paper cables, the cambric cables will carry somewhat smaller loads than given above. This note refers to v.c. cables for 2,300 volts and below. Higher-voltage v.c. cables will carry less amperes, relatively, than paper-insulated cables.

Higher Voltages—The chart cannot be used directly for 12,000-volt cable, for it contains no allowance for dielectric loss, nor for the lower limiting temperature—78 deg. C.—at the copper.

In the case of three-conductor, 500,000-circ. mil, paper-insulated sector cables manufactured within the past three years according to the new N.E.L.A. or A.E.I.C. specifications it can be said: For duct banks containing only 12,000-volt cables, the permissible amperes would be 94 per cent of the tabulated loads in winter, and 91 per cent in summer. For one or two 12,000-volt cables in a run, with a number of low-tension cables loaded according to the chart, the necessary reduction in loading would be far greater. For example, with the arrangements shown in Figs. *B, C, D,* and *F,* the 12,000-volt cables could carry 75 per cent of the tabulated loads, Fig. *E,* 62 per cent; Fig. *G,* 55 per cent for high-tension cables in the inside row of holes. Similarly for Fig. *H,* the percentages would be 100 per cent of the amperes in the table for the outside row of holes and 85 per cent for the second row of holes. I would not recommend 12,000-volt cable for the inside row. Similarly for Fig. *I,* a high-tension cable in the outer row of holes would carry 100 per cent of the tabulated amperes, in the second row 12 per cent, and inside row scarcely anything.

For older cable it is impossible to generalize. With very old cable the dielectric losses are very high. Practically all 12,000-volt cable made before and during the war must be loaded decidedly lower than outlined above. In many cases it will not carry more than half, perhaps less, the above percentages, in heavily-loaded banks.

With modern (1927 and later) 4,400- and 6,600-volt cable, only a few per cent reduction is necessary, say 25 per cent at most, inside heavily-loaded banks, and 5 per cent when favorably located. For older

cable less allowance is necessary than for 12,000-volt cable.

There is not a large factor of safety in these tabulated values of ampere loads. The paper will stand a little more temperature, but in the long run the lead will not. It will crack near the wipes on the splices and near the duct mouth in a few years, if A. I. E. E. standard temperatures are exceeded.

It must be remembered that a short stretch of bad ground, even 20 ft. or so, limits the load on the whole run of cable unless a larger cable is pulled through that section. In cases where local heating is unavoidable at some point, say, where a duct bank crosses a steam pipe tunnel, either build a manhole at each side and pass the duct under the tunnel with the ducts spread out only one deep or, if you must go over the tunnel, put in larger ducts and pull in much heavier cable.

Almost everyone underestimates the drying effect of a heavily-loaded duct bank on the earth surrounding it. A heavily-loaded, narrow bank like Fig. *E* is almost sure to bake a crust of earth around it; a bank like Fig. *I* may be depended upon to bake a very thick crust.

To those who are interested in using data such as given in this article, I recommend highly a little research work with a laborer and a spade. Have him uncover heavily-loaded duct banks where they cross over sewers, and at other bad points. See the earth condition for 2 to 6 in. around the duct itself on a few heavily- and lightly-loaded duct banks, and after a long dry spell. Always select the dry spots along the line.

■

Building Inspection and Maintenance

(Continued from page 246)

month to insure proper operation. Parts such as batteries and electrical controls for the transmission of signals should be tested individually.

Plumbing—General leakage, missing washers, cracked wash and toilet bowls, and clogged sewer drains are important faults to be searched for in the inspection of the plant system. Leakage occurs frequently in flushometer valves, ball-cocks, and faucets.

Practice at our plant is to service the plant plumbing once a month.

Yard Equipment—The condition of such yard items as hydrants, hose-houses, overhead and underground wires and cables, bridges, tracks and switches, drains, catch-basins, fences and gates, walks, drives, and runways should be reported weekly by the inspector and troubles found should be rectified. Hydrants should be checked for leakage and freezing. Hose-houses should contain the required fire-fighting equipment in good condition at all times. The condition of the poles, and insulation of overhead wires should be regularly observed.

Bridges should be checked for the condition of the paint and wearing surfaces. Rotting of ties and settling of the road bed should be searched for in inspecting railroad track. In my opinion a three-year schedule for replacement of ties provides adequate safety.

In my opinion, money spent in the operation of the system of inspection and maintenance outlined in this article, is well invested not only because of the expensive repairs prevented by its employment, but also in the removal of handicaps from production and the increased comfort and safety afforded the workers.

■

BOOKS

(Continued from page 249)

Light Frame House Construction

THIS bulletin, No. 145 of the Trade and Industrial Series No. 41, was compiled primarily for apprentice and journeyman carpenters, foremen, and apprentices under instruction. The major part of the bulletin is concerned with technical information relating to small frame building construction.

Numerous tables are included on loads and stresses, together with data on the comparative values of the various methods of bracing. Two chapters are devoted entirely to the characteristics of wood and the grading of lumber.

Copies, at 40 cents apiece may be obtained from the Federal Board for Vocational Education, Washington, D. C.

■

1931 American Standards Year Book

APPROVAL of 46 new national industrial standards including many important projects in the field of mechanical, electrical, civil, mining, and chemical engineering, is announced in the American Standards Year Book for 1931 published by the American Standards Association. There are also included many methods of test for petroleum products and lubricants.

In a foreword which reviews developments in national and international standardization during the past twelve months, Charles F. Kettering, president of the General Motors Research Corporation, declares that the lack of coordinated functioning within industries and between industries is a major cause of business fluctuations and states that the national standardization movement is making a definite forward step toward the correction of this situation.

■

Electrical Drafting and Design

By Calvin C. Bishop, Head of the Department of Drafting and Design, Technical High School, Buffalo, N. Y. Published by the McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, N. Y. Second edition cloth, 190 pages, illustrated. Price $2.

THIS practical text, bridging the gap between the average course in mechanical drawing and actual electrical drafting and design, has been revised to include new features and latest practice. To the information on electrical symbols and layout, switchboards, lighting, residence wiring, motor wiring, and outdoor substations has been added a chapter on an 11,000-volt installation and several new problems. Typical problems are worked through in detail in a manner approaching actual practice as closely as possible, and similar problems are presented for the reader's solution.

■

NELA Standard for Panelboards

THOSE who specify or order electrical wiring materials will be interested in the pamphlet of standards for panelboards and distribution boards issued by the National Electrical Manufacturers Association. This pamphlet shows design and construction features which years of experience and research have indicated to be satisfactory mechanically and electrically from the standpoint of safety and service. It was prepared by the Panelboard and Distribution Board Section of the association.

One section of the pamphlet contains a list of definitions of various terms used in connection with panelboards and distribution boards.

The pamphlet contains 32 pages bound in a linen-finish cover. Copies may be obtained from the National Electrical Manufacturers Association, 420 Lexington Avenue, New York, N. Y., at 50 cents each.

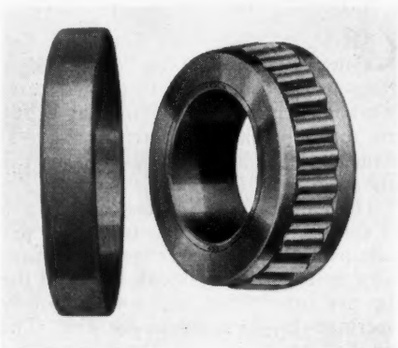
EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs.

Tyson Cageless Tapered Roller Bearings

CAGELESS tapered roller bearings are now being made by the Tyson Roller Bearing Corporation, Massillon, Ohio.

Absence of a cage or retaining ring is the principal feature of the bearing. Positive roll alignment is obtained by a double-ribbed backplate at the big end of the rolls. The shoulder of each roll gets a bearing on the inside rib of the backplate, and an additional bearing on the outside rib. Pintles at both ends of the rolls, extending into annular grooves in the backplate and closing ring, hold



the rolls in place when the cup is removed.

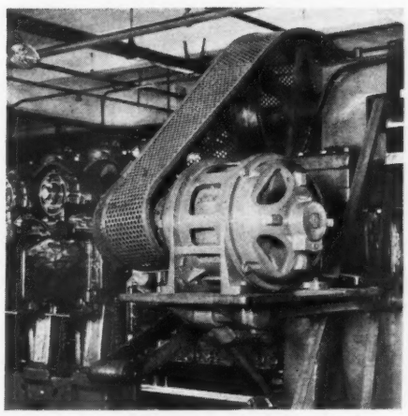
Bearings are made in all S.A.E. sizes and are interchangeable with all types of anti-friction bearing installations.

■

Westinghouse Motors

W-FRAME, Type CS, squirrel-cage induction motors, announced by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., have separable mechanical and electrical parts. This design is said to make maintenance simpler and less expensive, because damaged electrical parts can be replaced without rewinding the motor.

The stator core and its winding is pressed into the motor frame and may be removed as a unit. Likewise, the rotor is a complete separate unit, and



as such can be supplied for built-in applications and for repair.

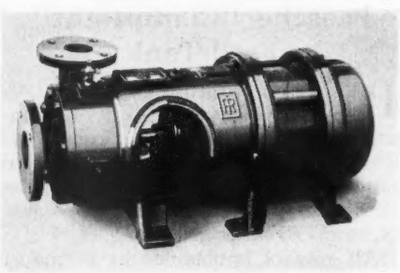
Separate-frame construction makes it possible to supply any one of a number of different types of frames to meet varying needs. Brackets are bolted to the frame with a ring-groove fit that sets the air gap and aligns the bearings, simplifying reassembly.

■

Ingersoll-Rand Pump

CLASS "RV" general-service centrifugal pump is announced by Ingersoll-Rand Company, 11 Broadway, New York, N. Y. Both pump and electric motor that drives it are assembled together. This construction minimizes the number of revolving parts and bearings and eliminates a coupling.

The pump is suitable for such applications as circulating and cooling systems, standpipe and water supply systems in factories, and general transfer and handling of any reasonably clear liquid.

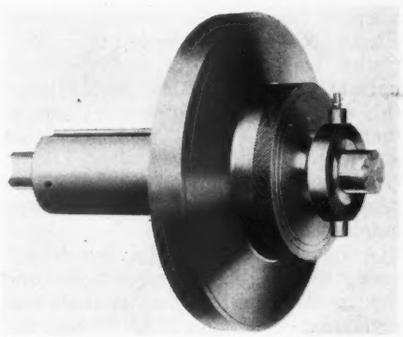


Units are made in six sizes and can be furnished mounted on a structural-steel bedplate to facilitate installation.

■

Dodge Diamond "D" Friction Clutches

COMPLETELY inclosed, safety, disk friction clutches, designed for both machinery applications and power transmission service, have been annouced by the Dodge Manufacturing Company, Mishawaka, Ind. The clutch is fully inclosed in both the engaged and disengaged positions which assures com-



plete safety as well as protection against dust and dirt. Asbestos friction disks with ground faces are used.

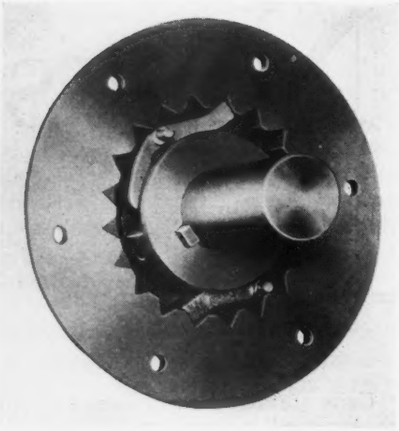
One point adjustment is provided. A heavy-duty slip ring in either the bronze or ball bearing type is used. The movement of this ring is positive and is not affected by wear of the friction material or by clutch adjustment.

■

Fairfield "Landahl Life-Time" Back Stop

ACCORDING to an announcement, shaft reversal may be prevented by use of a unit known as the "Landahl Life-Time" back stop manufactured by The Fairfield Engineering Company, Marion, Ohio.

Lubrication for the housing ends,



which serve as the shaft bearings, is provided by means of grooves running from the central oil bath. Pawls, pins and locking-rings are of steel, and the pawl-collar and housing are of cast-iron. Back stops are available in the plain-flange bearing and the pedestal-type bearing styles.

■

Lewis-Shepard Portable Cranes

PORTABLE cranes in four types have been introduced by the Lewis-Shepard Company, Watertown Station, Boston, Mass. In the hinged type, illustrated, both the boom and the main upright are hinged. The advantage of this design, the announcement states, is that it can be taken through small doorways.

A telescopic-type machine which can be made to accommodate various ceiling heights is also available.

A revolving hinged type which will swing through an arc of 360 deg. and the revolving telescopic type are the remaining two units. All these machines can be furnished with a hand worm-drive winch, a hand spur-drive winch, or an electric-drive winch. Air motors and gas engines may also be used if necessary. Cranes are made of arc-welded, structural-steel shapes. Anti-friction bearings are used in floor and sheave wheels. Capacities range from 500 to 2,000 pounds.

■

Miller "Duo-Purpose" Lighting Fixtures

IVANHOE Division of The Miller Company, Meriden, Conn., announces a line of "Duo-Purpose" lighting fixtures of the direct-semi-indirect type, each fixture having two circuits. One circuit is used for direct ultra-violet radiation and employs one S-1 "Sunlight Mazda" lamp. The other circuit is for semi-indirect lighting and employs six standard Mazda lamps of either 40, 60, 75, or 100 watts. Each circuit can be used separately or together. Fixtures operate only on 105- to 120-volt, 60-cycle, a.c. current.

■

Allegheny Steel Trade Name "Allegheny" to Apply to All Products

ACCORDING to an announcement, the Allegheny Steel Company, Breckenridge, Pa., will use the trade name "Allegheny" in connection with all of its products. The alloy formerly known as "Allegheny" metal will retain its name. Other alloys will be distinguished by the number following the trade name such as "Allegheny" 44, and so on.

■

Paasche "Clamptight" Feed Tank

PAASCHE Airbrush Company, 1909 Diversey Pkwy., Chicago, Ill., announces a line of tanks known as Paasche "Clamptight" pressure-feed paint tanks. An important feature is the method of opening and closing the cover by means of an eccentric.

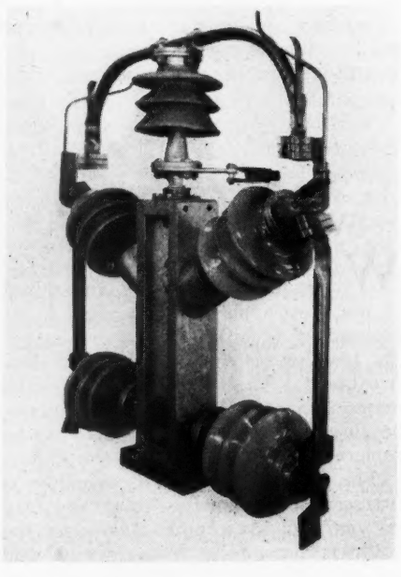
Air control is obtained by means of a 100-lb. air regulator and gage. The regulator diaphragm is compressed into position. Paint supply is strained through a double, vertical strainer. Tanks are made from one-piece pressed steel and are leaded to prevent corrosion. They are made in six sizes, from 3 to 60 gal. in capacity.

■

Champion Switch Unit

CHAMPION Switch Company, Kenova, W. Va., has developed a gang-operated disconecting and air-break switch. This combination is for use over an oil-circuit breaker for disconnecting the breaker and shunting the line to an auxiliary bus.

The announcement states that the use of this switch saves two insulators per pole over the usual arrangement. Insulator units of the air-break blades at the top are interlocked and simultaneously operated by a common handle. The six disconnecting switch blades mounted on the side are interlocked and operated



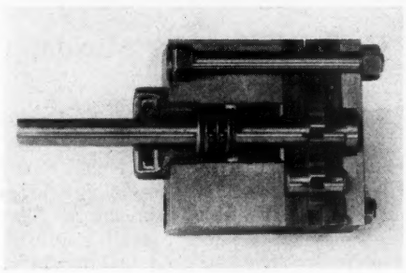
by one handle. Interlocks are furnished so that the air break and disconnecting-switch blades cannot be opened at the same time.

Ball bearings are of non-ferrous metal, the balls being of bronze and the ball races of Monel metal.

■

Northern Nitralloy Steel Pump

A PUMP body of solid steel is one of the features of the PX series pumps for fuel oil, gasoline, and lubricating oil, announced by the Northern Pump Company, Minneapolis, Minn. Gears operate between nitralloy plates. This design is said to prevent wear at sides of gears and furnishes nitralloy bearings. Nitralloy is said to be highly resistant to the chemical action of corrosive fuel oils and abrasive action of



sand and other solids. Countersunk nuts facilitate vertical mounting.

A spring provides automatic packing adjustment. Overall measurements are 6⅜ in. long, 3½ in. high, and 2⅛ in. wide.

■

Leatherok Flooring

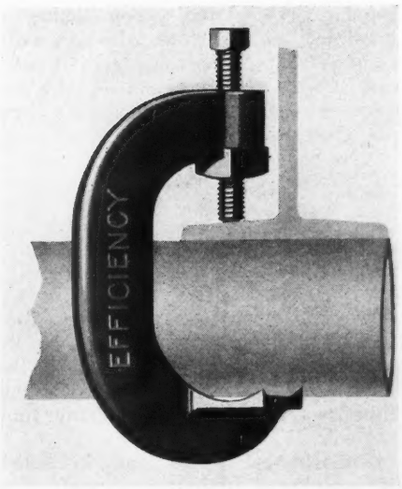
LEATHEROK Floors, Inc., 136 Federal St., Boston, Mass., announces a type of flooring known as Leatherok which, according to the announcement, is composed of leather and other fibers mixed and impregnated with asphalt emulsion. Flooring is available in strips 3 in. wide; ¼ in., ½ in., and ¾ in. thick; and any desired length.

■

Efficiency Electric Type F Conduit Hanger

TYPE F Efficiency conduit hangers have been announced by the Efficiency Electric and Manufacturing Company, East Palestine, Ohio.

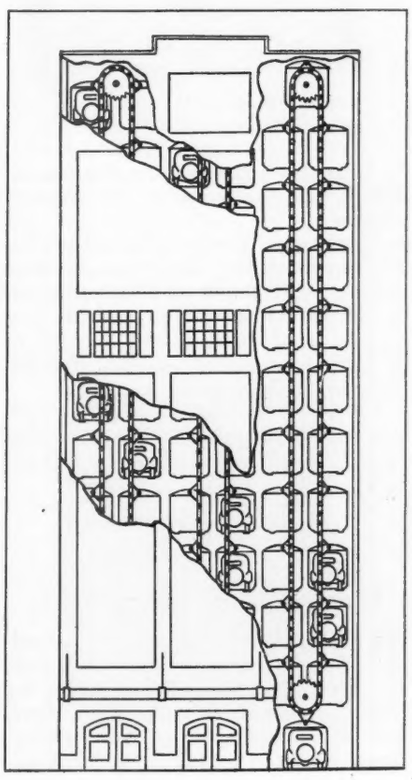
A case-hardened, cup-pointed set-screw is thrust through an unthreaded hole in the malleable-iron hanger and is tightened on the other side by a steel nut. The foot portion provides radiating ridges which grip the pipe at four separate points. Hangers are designed to carry pipe at any angle to the beam and to accommodate any one of several sizes. Three sizes of hangers are available for pipe up to 2½ inches.



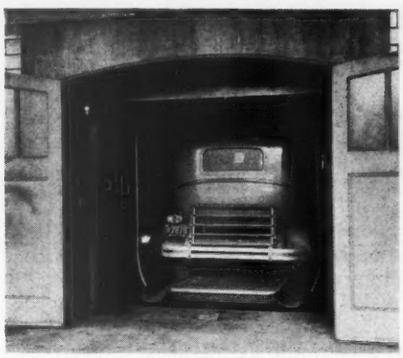
■

Westinghouse Vertical Parking Machine

AN automatic parking machine which enables the parking of 24 automobiles on a ground space little larger than that required by an ordinary double garage has been developed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The machine consists of cradles, one for each car, supported between two endless chains which pass over sprocket wheels at the top and the bottom of travel. Chains are driven by two electric motors, and, by means of a push-button control (or its equivalent), any cradle can be brought quickly to the driveway level for receiving or discharging an automobile.



Each machine of 24 parking spaces is 105 ft. high and occupies a ground area of 16 by 24 ft. for an automobile 18 ft. long. When desired, a lesser or



greater number than 24 cradles may be used. The machine may be arranged for loading and unloading at either the bottom or the top of the loop.

■

Amthor Mercury-Column Gages

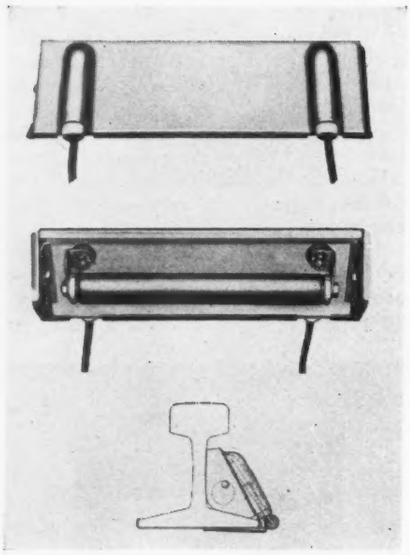
AMTHOR Testing Instrument Company, Inc., 309 Johnson St., Brooklyn, N. Y., announces mercury-column gages for low pressures and vacuum. Pressure gages are known as Type 410 and vacuum gages as Type 415. A case of U-shaped design is intended to protect the instrument from breakage. Each gage is provided with three connections threaded for union with ¼-in. standard pipe. Pressure gages are available in sizes from 5 to 25 lb. per sq. in. in capacity. Special gages may be furnished on order.

■

Electric Service Switch Heaters

SWITCH heaters, known as "Elec-Trac" switch heating units, have been announced by the Electric Service Supplies Company, 17th and Cambria Sts., Philadelphia, Pa. They are used for melting ice and snow from railroad switches. The required number of units are applied directly to the web of the rail.

Standard units have a capacity of 600 watts and operate on 110 volts. They may be connected in multiple on the



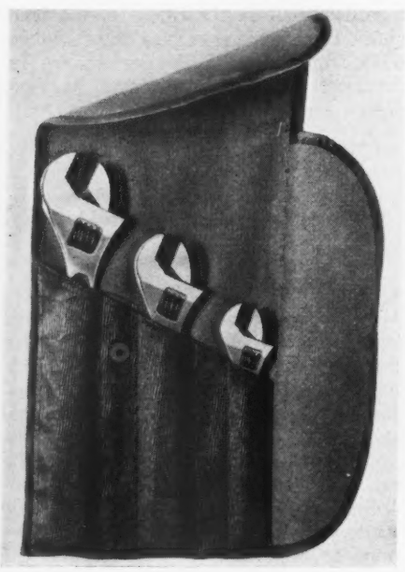
secondary side of a standard 110-volt transformer, two in series where it is preferred to use 220 volts, or five in series on 550-volt a.c. lines.

Each heater is a self-contained unit consisting of a pressed, copper-bearing, steel housing in which is mounted an asbestos insulator with an inclosed tubular heating element protected by a stainless-steel covering. The heating element is renewable. The asbestos board deflector serves both thermally and electrically as an insulator.

■

Crescent "Crestoloy" Wrench

"CRESTOLOY" is the trade-marked name of the steel developed by the Crescent Tool Company, Jamestown, N. Y., and used in the Crestoloy wrench which they announce. This wrench is similar in appearance to the regular Crescent tool except that it is one-third thinner and, the company claims, 200 per cent stronger. 6-, 8-, and 10-in. sizes are available, with capacities ranging from ¾ to 1⅛ inches.



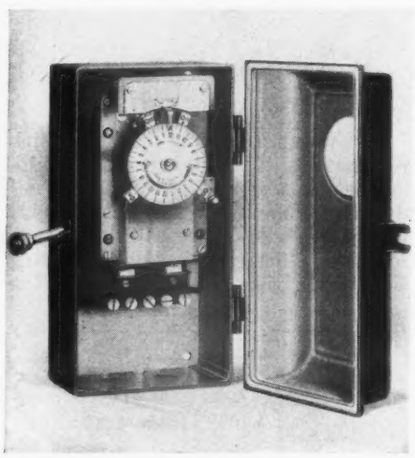
■

Cramer "Sauter" Time Switch

R. W. CRAMER & Company, Inc., 67 Irving Pl., New York, N. Y., announce an instrument known as the Type ZWE-15-II "Sauter" self-winding time switch, used for automatic time control.

Precision-cut gears and hardened, alloy-tool-steel pinions are used. The clock spring, automatically wound daily, has a reserve capacity of three to four days. The seven-jewel escapement has an Invar balance-wheel and a Breguet hair-spring and is interchangeable as a unit.

The field of the small induction motor can be connected in parallel or in series



by means of jumpers for operation on 100- to 120-volt or 200- to 240-volt a.c. circuits.

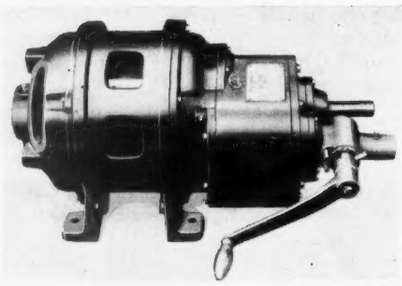
The toggle-operated, brush-type, double-pole switch has a wiping contact feature and locks in its closed position. It can be converted into a single-pole switch of 25-amp. capacity on 115 to 230 volts by means of a jumper arrangement on the terminal block.

Design of the dial is such as to control either one or two complete cycles daily. Arms may be set to suit requirements.

■

Westinghouse Gear Unit

BUILT in combination with a standard, squirrel-cage induction motor, this speed-reduction unit, known as the Westinghouse-Wise multi-speed drive, has been announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. The unit is designed to give four different speeds to the output shaft at constant horsepower. The announcement states that the speed of the driven apparatus may be changed without injury to the unit while the motor is running at full speed and under full load. Construction features include heat-treated and forged gears, ball bearings, and splash lubrication. Three sizes are available, ranging from ½ to 7½ horsepower.



■

General Electric "Mazda" Lamp

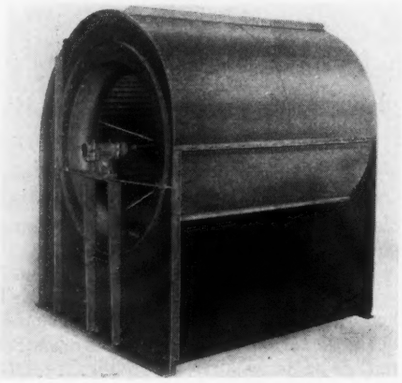
TYPICAL applications of the 5-watt Mazda lamp, announced by the General Electric Company, Nela Park, Cleveland, Ohio, are its use in signalling devices and elevator annunciators. The lamp has a maximum overall length of 1⅞ in. and may be used in 110-, 115-, and 120-volt circuits.

■

American Blower "Sirocco" Fans

AMERICAN Blower Corporation, Detroit, Mich., announces a line of "Sirocco," Series 30 fans. They may be obtained for two types of service; class I for heating and ventilating, and class II for severe industrial applications.

A number of narrow curved blades, pitched forward at an angle, feature the design of the wheels. The line is available in sizes ranging from 30 to 300,000 c.p.m. Larger sizes may be designed on special order to suit requirements.



Okonite "Okosheath" Cable

ANNOUNCEMENT is made by the Okonite Company, Passaic, N. Y., of a line of cable for underground duct work or burial, known as "Okosheath." The conductor is covered with a single sheath of rubber compound and is available only in the single-conductor type for 600-volt service and in sizes ranging from No. 14 A.W.G. to 2,000,000 circular mils.

■

Century Reversible Fans

PREVIOUSLY equipped with a reversing switch built in the unit, the reversible 36- and 60-in. ceiling fans announced by the Century Electric Company, St. Louis, Mo., now may be controlled by a wall switch. When not

arranged for lighting fixtures, fans may be controlled by a three-speed, pull-cord switch.

■

Ideal Adjustable Growlers

ADJUSTABLE internal and external growlers have been added to its line by the Ideal Commutator Dresser Company, Sycamore, Ill. The internal type is made in two sizes for use on stators with openings from 5½ to 60 in. in diameter. This unit is hinged at the top and has a switch in the handle, a 6-ft. flexible cord, and an attachment plug.

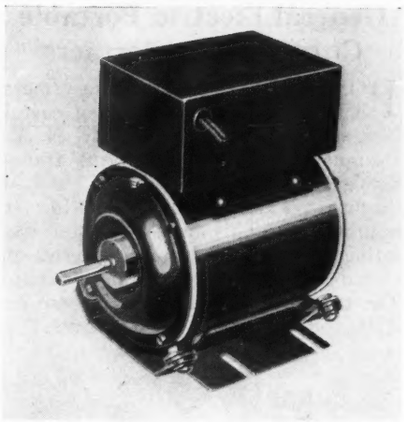
The external unit is made in five sizes for armatures from ¾ to 30 in. in diameter and is hinged at the base for adjustment. It operates on 110-volt, 60-cycle current only.

■

Howell Motors

FRACTIONAL-HORSEPOWER motors ranging in size from 1/10 to 1/3 hp., have been announced by the Howell Electric Motors Company, Howell, Mich. They are known as Type CI.

Motors are squirrel-cage construction



and condenser starting. The condenser box is mounted on top of the motor, but may be located elsewhere if desired. Either ball or sleeve waste-packed bearings may be furnished.

■

General Electric Easy-Bending Conduit

RIGID conduit made of a flexible alloy-steel that permits easy bending has been announced by the General Electric Company, Bridgeport, Conn. According to the announcement, the conduit may be bent across the knees without tools.

■

American "AmerTran" Oil Test Set

DESIGNED to permit dielectric-strength measurements of transformer oil in the field, the test set, Type TS-6B, introduced by the American Transformer Company, 178 Emmet St., Newark, N. J., incorporates safety devices which make it impossible to come in contact with high-voltage parts while the set is in operation.

High-potential parts are completely inclosed and the oil cup is located in a compartment equipped with a switch

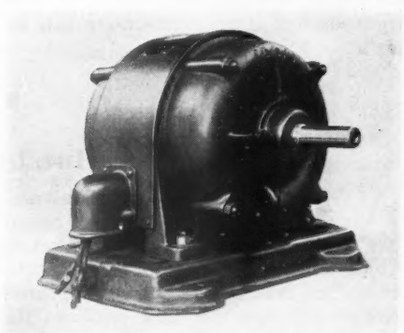
which opens the power circuit when the lid is raised. The cover to this compartment is also fitted with a glass window to permit visual inspection of oil during a test.

The improved voltage regulator consists of a collapsible crank mounted on the outside of the case and coupled to the potentiometer slider through a worm gear. The set is housed in a welded sheet-steel case and employs a 30-kv. testing transformer with a rating of 0.5 kva. Other equipment includes circuit breaker, voltmeter, wire-wound potentiometer, bakelite oil cup, pilot light, power switch, and detachable connection cord.

■

Ideal Drip-Proof Motors

DRIP-PROOF unit-type motors have been added to its line by the Ideal Electric & Manufacturing Company, Mansfield, Ohio. These units are designed for installations where it is necessary to wash down equipment with a water spray. As water is thrown into the motor it is immediately discharged



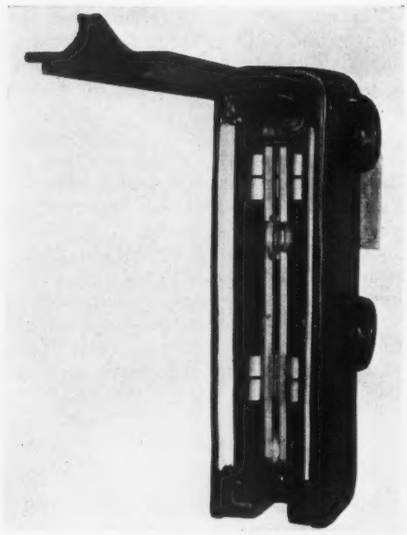
through a vent at the bottom of the center inclosing jacket. Air circulation is from both ends toward the center and out through this vent.

Shrouded fans located inside the end brackets produce the action which discharges the water. These fans catch any water entering through the end of the motor and throw it against the inside surface of the bearing brackets. From here the water runs out through the bottom vent without coming in contact with the windings. End brackets are designed to prevent dripping water from entering the motor.

■

Matthews Disconnecting Switch

AN ADDITION to its line of fusing equipment, the No. 475 porcelain-housed disconnecting switch with a rating of 400 amp., 7,500 volts, has been announced by the W. N. Matthews Corporation, St. Louis, Mo. This unit has a blade consisting of two pieces of bus-



bar copper. When in an open position the blade is dead and is insulated from the contacts. Contacts are of the flat-surface pressure type. Terminals of the cast-copper clamp type are designed to take a 4/0 stranded lead. Housing is of wet process porcelain and is provided with four entrance wire holes so that right or left hand connections can be made.

General Electric Portable Current Transformers

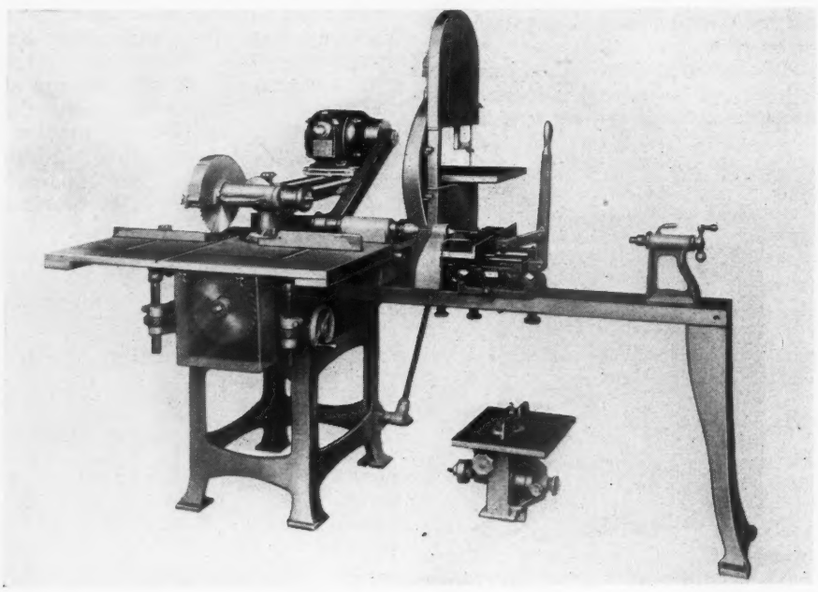
PORTABLE current transformers have been announced by the General Electric Company, Schenectady, N. Y. Designated as Type PR-1, the transformer measures 3⅝in.x9¼in., with a height over terminals of 9⅞ in. It weighs 13 lb. This multi-range unit has ratings up to 1,100 amp. in a series of eleven steps. Secondary rating is 5 amp. The transformer is suitable for use on 2,500-volt, 25- to 125-cycle circuits.

■ ■

Porter-Cable-Hutchinson "Beaver Shop"

A COMBINATION woodworking machine known as the "Beaver Shop" has been introduced by the Porter-Cable-Hutchinson Corporation, Syracuse, N. Y. In addition to the overhead cut-off saw and the table rip saw, the machine has a jointer, 14- or 16-in. band saw, lathe, shaper, mortiser, and boring attachment. Each unit is individually driven by the same motor, and any of the units can be used without the material touching any of the other units.

All moving parts run on ball bearings. Housings are packed with cup grease sufficient for one year's operation. The power unit may be either a dust-proof electric motor or an air-cooled gas engine. A series parallel switch, mounted on the front of the motor, is fitted with bus bars for changing from 110- to 220-volt circuit without changing the wiring.



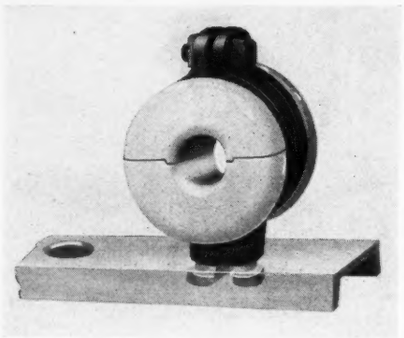
The metal case is crystalline-lacquered, and the cover is of black Textolite. Core and windings are attached to the cover, which is removable for inspection.

■

Efficiency Electric Type B Cable Rack

EFFICIENCY Electric and Manufacturing Company, East Palestine, Ohio, announces a line of cable-suspension equipment known as type B cable racks. Racks may be mounted permanently and cables added as required by inserting the hangers where desired.

Racks are of rolled steel channel finished with rust-resisting paint. The cable hanger is a clamping device which simultaneously supports the bushing and spreads the flanged feet which engage



the sides of the hole in the rack. Both operations are performed by tightening one bolt. Bushings and cleats are of glazed, vitrified porcelain. Hanger parts are of malleable iron.

■

Austin "Big Chief" Soap

AUSTIN Accessories Manufacturing Company, Inc., 2632 Shields Avenue, Chicago, Ill., has introduced a medicated, powdered, hand soap under the name "Big Chief." The soap is made from a well-known brand combined with pure pumice and, it is claimed, penetrates and removes grease, oil, paint, and dirt, and other such material.

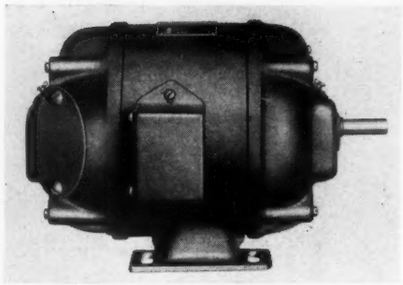
The soap is sold in 7-oz. cans, or in bulk with a dispenser.

■

Century Motors

CENTURY Electric Company, St. Louis, Mo., announces a line of fractional-horsepower motors available in repulsion-start induction single-phase, split-phase, single-phase, squirrel-cage induction, three-phase, and d.c. types.

Motors have rolled-steel frames, weld-

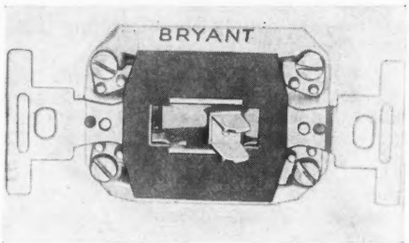


ed-steel feet, slots for belt adjustment, phosphor-bronze bearings, and wool-yarn lubrication. Mounting dimensions of the different types are interchangeable.

■

Bryant Flush Tumbler Switch

ANNOUNCEMENT is made by The Bryant Electric Company, Bridgeport, Conn., of a flush tumbler switch with a stamped-steel handle. The switch has been designed particularly for use

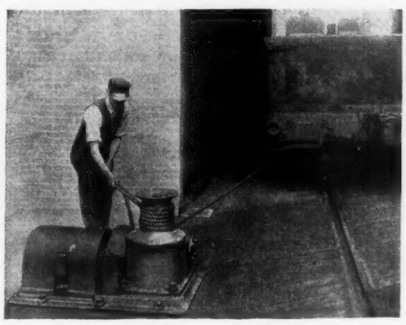


in vapor-proof boxes where it is operated by means of an outside handle. Such applications are found in paint and lacquer rooms, oil refineries, and explosive factories. The cup is of porcelain. Ears on the mounting yoke are of plaster. The switch is rated 10 amp. for 125- or 250-volt service.

■

Webster and Weller Car Puller

ANNOUNCEMENT has been made by the Webster and Weller Manufacturing Companies, 1856 North Kostner Ave., Chicago, Ill., of a car-pulling



unit, known as the Weller capstan car puller. This electrically operated unit is self-contained, and is available in three sizes to handle from one to six 80-ton cars.

■

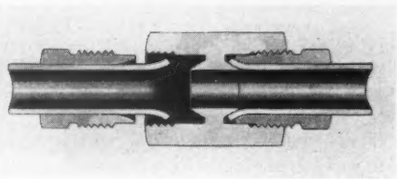
Armite Hard-Facing Products

HARD-FACING products for application on friction surfaces have been developed by the Armite Laboratories, Los Angeles, Calif. These materials may be applied with the electric arc or by the oxy-acetylene method. Several grades of inserts and compounds ranging in size from 20-mesh to ½ in. in diameter have been developed for application to drilling bits, power-shovel teeth, and for other services where inserts are desirable.

Bailey Compression Fittings

"DIEFORM" compression fittings and tubing have been announced by the Bailey Meter Company, 1050 Ivanhoe Road, Cleveland, Ohio. They are designed for use in small service lines in power plant and industrial field.

The nuts on the compression fitting and the seat in its center serve as a die to the flared ends of the tubing. Brass, Monel metal, or steel compression fittings with copper or steel tubing are recommended for piping where many bends must be made in the line, or where a tight installation is required for high-pressure or high-temperature service.



TRADE LITERATURE

For copies, address the manufacturers concerned

■

(133) FANS—Bulletin 168, non-oscillating, oscillating, one-speed, three-speed, and ceiling-type fans.—Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo.

(134) IMMERSION HEATERS — Leaflet GEA-214B, helicoil sheath-wire immersion heaters.—General Electric Company, Schenectady, N. Y.

(135) MATERIALS HANDLING—Booklet, 10 pages, materials handling equipment for central proportioning and concrete-mixing plants, use of the photo-electric cell in mixing concrete.—Stephens-Adamson Manufacturing Company, Aurora, Ill.

(136) ABRASIVES — Folder, "Cass" stones for smoothing commutators.—Electric Service Supply Company, 111 N. Canal St., Chicago, Ill.

(137) GLUEPOTS — Leaflet GEA-193A, electrically heated gluepots.—General Electric Company, Schenectady, N. Y.

(138) STEEL PRODUCTS—Booklet, products of the American Chain Company, Inc., and associate companies. — The American Chain Company, Inc., Bridgeport, Conn.

(139) MOTORS—Leaflet GEA-1275, Type BC, fractional-horsepower d.c. motors.—General Electric Company, Schenectady, N. Y.

(140) INSTRUMENTS—Catalog 211, 144 pages, instruments, relays, and electronic devices.—Westinghouse Electric & Manufacturing Company, Newark, N. J.

(141) WELDING—Booklet M1, 8 pages, copper welding by the "Premag" process.—Murex Welding Processes, Ltd., Forest Road, London, East 17, England.

(142) FANS—Bulletin 41, 12 pages, a.c. and d.c., stationary, oscillating, ceiling, and ventilating fans.—Century Electric Company, 1806 Pine St., St. Louis, Mo.

(143) MOTOR INCLOSURES—Booklet, 12 pages, electric motor inclosures for open-frame motors.—Daun-Walter Company, Milwaukee, Wis.

(144) MOTORS—Folder 116, protected motors.—Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles, Calif.

(145) MATERIALS HANDLING—Bulletin 401-1, portable belt conveyors and their applications.—The Fairfield Engineering Company, Marion, Ohio.

(146) CONTROL EQUIPMENT — Bulletin H-2, 12 pages, charts showing the operation of Brooke electrically actuated pressure-control equipment. — Brooke Engineering Company, Inc., 3640 N. Lawrence St., Philadelphia, Pa.

(147) VENTILATION—Folder, Airmaster exhaust fan and the Airmaster five-blade patented propeller.—Airmaster Corporation, 140 S. Dearborn St., Chicago, Ill.

(148) HEAT TREATING—Circular, "Scientific Heat Treating." — The Vincent Steel Process Company, 2434 Bellevue Ave., Detroit, Mich.

(149) CARBON PRODUCTS—Catalog Section—B-131, 24 pages, "Pyramid" commutator brushes.—National Carbon Company, Inc., Carbon Sales Division, Clevelnad, Ohio.

(150) ROLLER CHAINS—Booklet "Sim-

plifying and Improving Machine Design," roller chains and machine designs.—Diamond Chain and Manufacturing Company, Indianapolis, Ind.

(151) COMMUTATOR STONES — Circular 233, Cass commutator smoothing stones.—Electric Service Supplies Company, 111 N. Canal St., Chicago, Ill.

(152) PIPE BENDING—Bulletin 50, 12 pages, "Principles and Practice of Bending Byers Genuine Wrought Iron Pipe."—A. M. Byers Company, Clark Building, Pittsburgh, Pa.

(153) NICKEL STEEL—Folder 8 of a series, "Use and Applications of Nickel Steel in Various Industries."—The International Nickel Company, Inc., 67 Wall St., New York, N. Y.

(154) CONTROL EQUIPMENT — Bulletin 803, motor-driven controls and timers for lighting and signal systems. — Reynolds Electric Company, 2650 W. Congress St., Chicago, Ill.

(155) TESTING—Brochure, "Fifty Years of Service to Industry," commemorating the fiftieth anniversary of this organization. — Pittsburgh Testing Laboratory, Pittsburgh, Pa.

(156) TRACTORS—Form 304, Model GH Trackson McCormick-Deering crawler tractor.—Trackson Company, 1320 S. First St., Milwaukee, Wis.

(157) METERS — Bulletin 70, 4 pages, power-type pressure devices. — Bailey Meter Company, 1050 Ivanhoe Rd., Cleveland, Ohio.

(158) PUMPS—Specification sheet W-112-S10, 4 pages, horizontal, duplex, piston-pattern oil pumps.—Worthington Pump & Machinery Corporation, Harrison, N. J

(159) MATERIALS HANDLING — Catalog 24, molded, conveyor, and ball-bearing pulleys and sheaves. — Henry Lindahl Foundry & Machine Company, 5900 Ogden Ave., Chicago, Ill.

(160) MOTORS—Bulletin 4-1, split-phase motors from 1/20 to 1/4 hp.—Century Electric Company, 1806 Pine St., St. Louis, Mo.

(161) SWITCHBOARDS—Bulletin CA-508, 8 pages, dead-front switchboards.—Square D Company, Switch and Panel Division, 6060 Rivard St., Detroit, Mich.

(162) LUBRICATION—Bulletin 7A, 12 pages, pressure-vacuum oil filters.—Wm. W. Nugent & Company, Inc., 410 N. Hermitage Ave., Chicago, Ill.

(163) PIPE COVERING—Price list, 16 pages, cork covering for low-temperature pipe lines.—L. Mundet & Son, New York, N. Y.

(164) INGOT IRON—Pamphlet, Armco "Metalcurb."—The American Rolling Mill Company, Middletown, Ohio.

(165) POWER TRANSMISSION—Booklet, 12 pages, "The Effect of Belt Tensions on the Cost of Belting."—Alexander Brothers, 14 South St., Philadelphia, Pa.

(166) STEAM TRAPS—Folder 48, 8 pages, Sarco thermostatic steam traps for individual trapping systems.—Sarco Company, Inc., 183 Madison Ave., New York, N. Y.

(167) CONDUIT FITTINGS—Bulletin 901, 24 pages, Appleton no-thread malleable Unilets.—Appleton Electric Company, 1701 Wellington Ave., Chicago, Ill.

(168) PUMPS — Specification Sheet D-423-E8, 2 pages, vertical, triplex, single-acting power pumps.—Worthington Pump & Machinery Corporation, Harrison, N. J.

(169) MOTORS—Leaflet 20519, Type HR, "Simplex" synchronous motors.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(170) CONTROL EQUIPMENT — Catalog 8008, 48 pages, automatic control for temperatures, pressures, flows, liquid levels, and other operating factors.—The Brown Instrument Company, Philadelphia, Pa.

(171) ELECTRICAL PRODUCTS — Sheet M-3, fast-blowing, Universal Matthews fuse links.—W. N. Matthews Corporation, St. Louis, Mo.

(172) CARBON BRUSHES—Manual designed to simplify the selection and specification of carbon and metal-graphite brushes.—National Carbon Company, Inc., Carbon Sales Division, Cleveland, Ohio.

(173) M-G SETS—Folder 20-1, 4 pages, Century-Roth M-G sets in sizes from 50 watts to 100 kw.—Roth Brothers & Company, Division of Century Electric Company, 1400 W. Adams St., Chicago, Ill.

(174) CONCRETE — "Universal Atlas Handbook of Concrete Construction," 208 pages.—Universal Atlas Cement Company, 208 S. La Salle St., Chicago, Ill.

(175) INSULATION—"Isolation" Vol. 3, No. 1, a publication devoted to the study and application of sound proofing of buildings and the isolation of machine vibration.—Korfund Company, Inc., New York, N. Y.

(176) POWER TRANSMISSION—Folder, 4 pages, Crocker-Wheeler motor and speed-changer units.—Crocker-Wheeler Electric Manufacturing Company, Ampere, N. J.

(177) FITTINGS—Bulletin 13, 14 pages, "Dieform Compression Fittings."—Bailey Meter Company, 1050 Ivanhoe Rd., Cleveland, Ohio.

(178) POWER TRANSMISSION — Catalog 301, 80 pages, IXL "Hygrade" worm reducers.—Foote Bros. Gear and Machine Company, 215 N. Curtis St., Chicago, Ill.

(179) MATERIALS HANDLING—Spiral conveyor catalog 495, description and prices.—The Jeffrey Manufacturing Company, Columbus, Ohio.

(180) POWER TRANSMISSION—Book 1293, "A Saving at Every Turn," a complete line of positive drives.—Link-Belt Company, 910 S. Michigan Ave., Chicago, Ill.

(181) WELDING—Booklet, "Manual of the Electric Torch," description, design, and application. — Warner Engineering Corporation, Ltd., Pomona, Calif.

(182) CIRCUIT BREAKERS—Circular 1913, 8 pages, "Nofuze Load Centers" for branch circuits.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(183) CONTROL EQUIPMENT—Broadside, indicating control for high-temperature processes and units.—Brown Instrument Company, Wayne and Roberts Aves., Philadelphia, Pa.

(184) DISTRIBUTION SYSTEMS — Catalog 15, 240 pages, loose-leaf form, complete electrical distribution and control systems.—The Trumbull Electric Manufacturing Company, Plainville, Conn.

(185) MATERIALS HANDLING—Bulletin L-2, 8 pages, "Loadmaster" crane.—Bucyrus-Erie Company, South Milwaukee, Wis.

(186) INSTRUMENTS—"Pocket Manual of 'Megger' Practice," No. 1150.—James G. Biddle Company, 1211-13 Arch St., Philadelphia, Pa.

(187) AIR COMPRESSORS—Bulletin, 16 pages, "4 Air Compressors Went to School."—Davey Compressor Company, Inc., Kent, Ohio.

(188) METALS — Bulletin, "Engineering Metals for the Process Industries," 56 pages.—The International Nickel Company, Inc., 67 Wall St., New York, N. Y.

(189) PRESSURE REGULATORS — Catalog, Spence line of pressure-regulating equipment.—Spence Engineering Company, Inc., 110 E. 42 St., New York, N. Y.

COMING EVENTS

American Gear Manufacturers Association—15th Annual Meeting, Hotel Statler, Buffalo, N. Y., May 7 to 9, 1931. Secretary, T. W. Owen, 3608 Euclid Ave., Cleveland, Ohio.

National Fire Protection Association—35th annual meeting, Toronto, Can. May 11 to 14, 1931. Association headquarters, 60 Batterymarch St., Boston, Mass.

National Association of Purchasing Agents—Sixteenth International Convention, Royal York Hotel, Toronto, Can., June 8 to 11, 1931. G. A. Renard, Secretary-Treasurer, 11 Park Place, New York, N. Y.

National Electric Light Association—54th convention and exhibition, Municipal Auditorium, Atlantic City, N. J., June 8 to 12, 1931. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York, N. Y.

Association of Iron and Steel Electrical Engineers—Iron and Steel Exposition, Cleveland Public Auditorium Annex, Cleveland, Ohio, June 15-19, 1931. Managing Director, John F. Kelly, Empire Bldg., Pittsburgh, Pa.

American Society for Testing Materials—Annual meeting, Stevens Hotel, Chicago, Ill., June 22-26. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Institute of Electrical Engineers — Annual summer convention, Asheville, N. C., June 22-26. Secretary, F. L. Hutchinson, 33 West 39th St., New York, N. Y.

American Welding Society—Fall Meeting and Exposition, Boston, Mass., Sept. 21 to 25, 1931. Secretary, M. M. Kelly, 33 West 39th St., New York, N. Y.

Illuminating Engineering Society—Annual convention, Hotel William Penn, Pittsburgh, Pa., Oct. 13 to 16, 1931. Assistant Secretary, Frank G. Horton, 29 West 39th St., New York, N. Y.